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Vol. XVII, No. 12

OCTOBER, 1958

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Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
JOSEPH ASHBROOK, *Technical Editor*

Vol. XVII, No. 12 OCTOBER, 1958

CONTENTS

COVER: The late Albert G. Ingalls, mentor of amateur telescope makers, at Sunday breakfast on August 7, 1938, at Springfield, Vermont. Beside him is David O. Woodbury (with cigarillo), collecting background material for his book, "The Glass Giant of Palomar." On the shelf behind them are the bean pots used the day before at the annual Stellafane outdoor supper. Photograph by Robert E. Cox. (See page 616.)

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Migrating Birds Use Stars To Navigate

SOME SPECIES of migratory birds are guided by the stars in their travels of many thousands of miles, according to the experiments of German ornithologist E. G. F. Sauer, Freiburg University. The best evidence comes from the European warblers, which spend their summers in northern Europe and winter in Africa.

Earlier studies in England and Germany have shown that homing pigeons and wild birds can use the sun as a compass, and have a time sense allowing them to take into account the diurnal motion of the sun. But the European warblers fly mostly at night – individually, not in flocks – so Dr. Sauer and his coworkers carried out extensive experiments to find how they navigate.

Warblers of several species were hatched and raised in completely enclosed chambers where the illusion of eternal summer was maintained. Yet in early autumn, at the time of their southerly migration, these birds showed great restlessness, flitting about or fluttering over their perches night after night for many weeks, approximately the length of time it would have taken them to fly to Africa. This indicated the existence of a built-in "calendar sense."

When, at the season for migration, lesser whitethroat warblers were placed in a glass-topped cage from which the starry night sky was visible, each would take up a position pointing southeast, in the direction for the first half of the migration path across the Balkans. But when the stars were hidden by clouds, or when only diffuse light entered the glass roof, the birds became completely disoriented.

In further experiments, cages of these warblers were placed inside a planetarium dome. When the artificial sky matched the constellations as seen from Germany at the season of migration, the birds took up the proper direction just as if seeing the natural sky. When the planetarium projector was set for more southerly latitudes, the warblers tended to face more and more southward, until at latitude 15° north they were poised for a course due south, corresponding to the last part of their journey up the Nile River.

There is no doubt, writes Dr. Sauer in his detailed article in *Scientific American* for August, "that the warblers have a remarkable hereditary mechanism for orienting themselves by the stars – a detailed image of the starry configuration of the sky coupled with a precise time sense which relates the heavenly canopy to the geography of the earth at every time and season. At their very first glimpse of the sky the birds automatically know the right direction."

A dish of glittering aluminum mesh 84 feet across looks skyward to catch radio noise from the depths of space. This is the U. S. Naval Research Laboratory's new radio telescope at Maryland Point on the Potomac River. Besides being the largest steerable radio telescope in the United States, it is the biggest one with this type of mounting in the world. The instrument will be used primarily for studies of the radio continuum and to observe the 21-centimeter line of neutral hydrogen. Official U. S. Navy photograph.

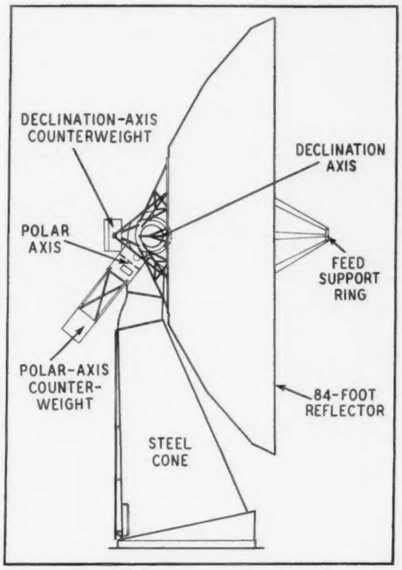
The Naval Research Laboratory's 84-foot Radio Telescope

EDWARD F. MCCLAIN, *Radio Astronomy Branch, U. S. Naval Research Laboratory*

THE LARGEST steerable radio telescope in the United States has recently been completed at the Naval Research Laboratory's new Maryland Point Observatory in Charles County, Maryland. Carried on a polar or equatorial mount, its 84-foot paraboloidal aluminum reflector can be aimed at any point in the sky and can track any celestial object from horizon to horizon. It is the biggest antenna with this type of mounting in the world.

Originally ordered in June, 1955, the instrument has been three years in design, construction, and erection; it is the work of D. S. Kennedy Co., Cohasset, Massachusetts. The polar and declination axes, with their respective drive components, are mounted at the top of a hollow truncated steel cone approximately 40 feet high. Steel trusswork attached to the declination axis carries the reflector, which weighs only 15,000 pounds. The total weight of the instrument is about 169,000 pounds, exclusive of 252 cubic yards of concrete in the foundation.

To the tubular aluminum trusswork that forms the back of the reflector is attached a surface of $\frac{3}{8}$-inch-square aluminum mesh. The design specification called for a maximum deviation from a true paraboloid of $\pm\frac{3}{8}$ inch, permitting operation at wave lengths as short as 10 centimeters. To facilitate construction, the reflector was fabricated in 80 individual radial panels of different shapes, each matched to a male mold. These sections were then accurately assembled in position and checked with a Wild T-1 precision theodolite. Ninety check points at the panel corners were measured and, following adjustment, approximately 10 of these check points approached zero error, about 10 approached $\frac{3}{8}$-inch error, and the remainder were of the order of $\frac{1}{4}$ inch.



A cross-section plan of the 84-foot telescope from the west, showing the location of the polar and declination axes. The hollow cone is 40 feet high.

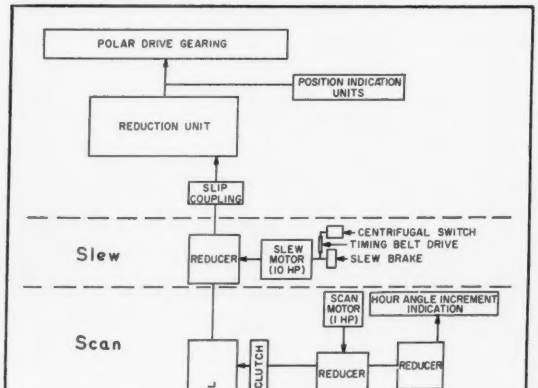
Many large radio telescopes have altazimuth mountings, requiring a co-ordinate converter to change from equatorial celestial co-ordinates to altitude and azimuth. In following the path of a celestial object across the sky, however, the altitude-azimuth velocities are not constant and the altitude velocity must go through zero and change direction as the telescope crosses the meridian.

With an equatorial mounting, where the polar axis is parallel to the earth's axis, the telescope need be driven in hour angle only, at the constant sidereal rate, to compensate for the earth's rotation. The advantages of the polar mount are partially offset, in large radio telescopes, by the severe structural problem that arises in transferring the mechanical load of the dish to the supporting structure as the dish rotates from east to west. This mechanical problem has been effectively overcome in the Kennedy design with no sacrifice in sky coverage.

The block diagrams show the scheme of the drive systems. For both polar and declination axes there are two drive modes. A 15-degree-per-minute slew mode permits rapid motion from one point in the sky to another; a second so-called scan mode permits any velocity from about ±0.1 to ±1 degree per minute to be imparted to either or both axes. The scan motions may be used while the telescope is tracking at the sidereal rate, and are a great convenience in mapping and positional work.

As may be seen from the diagrams, no servo mechanisms are employed in the

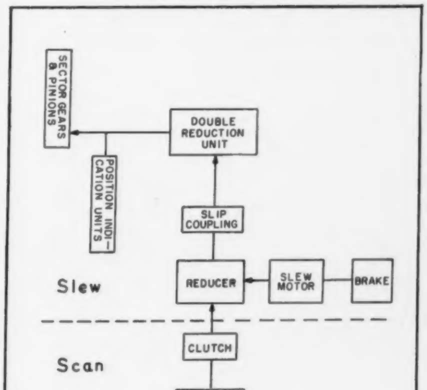
RIGHT-ASCENSION DRIVING SYSTEM

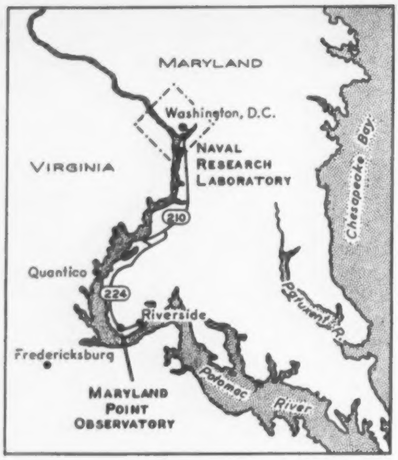


Left: A block diagram to show the relation of the three ways of driving the telescope in right ascension. The slew mechanism is for rapid pointing from one part of the sky to another; the scan system permits any velocity from 1/10 to one degree per minute; and the track gear operates the telescope at the normal sidereal rate.

Right: In the declination driving system, the slew and scan mechanisms operate at the same rates as on the right-ascension drive. All illustrations with this article are courtesy of the Naval Research Laboratory.

DECLINATION DRIVING SYSTEM





Maryland Point Observatory, an hour's drive south from Washington, D. C., is at the quietest site, from the standpoint of radio noise, within 50 miles of that city.

drive systems, and all drive motors are under the direct control of the operator by means of keys at the control console. Horizon, polar-axis, and north-celestial-pole limit switches are provided to prevent the operator from moving the telescope beyond the limits of the design. Dials on the console display the actual position of the antenna and the condition of the polar-axis scan drive at all times.

To check the orientation of the axes, a 5-inch camera was mounted in the polar-axis housing and pointed to a field surrounding Polaris. Two- and four-hour exposures were taken with the right-ascension driving system operating, and after adjustment the polar-axis alignment was found to be within 30 seconds of arc. A second camera was used for multiple exposures at different declinations while tracking, and it indicated that the polar and declination axes were perpendicular to each other to within about one minute of arc.

Following the mechanical tests, a new 10-centimeter radiometer designed by R. M. Sloanaker, of the radio astronomy branch of NRL, was installed in the 84-foot instrument. A survey of the brighter cosmic radio sources was undertaken to permit final adjustment of the focal-point mounting ring. This work is still under way, but indications are that the instrument will easily perform with the absolute pointing accuracy of ±2 minutes of arc required in the specifications. It is hoped that with sufficient study of systematic errors we can ascertain relative positions within one minute of arc.

The aperture efficiency was found to be about 40 per cent, based on the survey made by NRL astronomers with our 50-foot dish some four years ago, and agreed quite well with work at Bell Laboratories in 1956 for a surface accurate to ⅛ wave length.

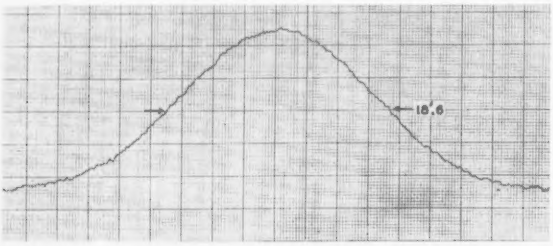
A drift curve of Cassiopeia A made with the new instrument is reproduced below. The beam-width at half-power points is about 18½ minutes of arc, while the calculated beam-width is 17 minutes. A slight broadening might be expected due to the finite size of the source. No antenna pattern measurements have been attempted yet, but the Cassiopeia A drift curves appear to indicate that the side lobes of the pattern are not excessive.

The new observatory is on Maryland state highway 224, five miles west of Riverside, Maryland, on the north shore of the Potomac River. We conducted noise surveys at a number of sites around Washington, D. C., using the same equipment as that employed in the preliminary search for a national radio observatory site by Associated Universities, Inc. Maryland Point was by far the quietest site investigated within 50 miles of Washington, and compared favorably with the third or fourth choices in the AUI survey (for which the first choice was Green Bank, West Virginia). In both surveys, noise level seemed to correlate rather closely with population density.

Our specific location was chosen because of an unrestricted southern horizon over a broad part of the Potomac River. The site is approximately 45 miles from the Naval Research Laboratory and requires about an hour's travel by automobile.

It is expected that the 84-foot will be used for radio continuum studies at the longer wave lengths and for neutral hydrogen studies at 21 centimeters. It is hoped that the noise-free location will permit meaningful measurements of the spectra of radio sources at frequencies as low as 100 or 200 megacycles per second. In addition, the instrument will probably be used from time to time for radar studies of the moon.

Among those who have assisted me in this work at the NRL radio astronomy branch are C. R. Grant, J. E. Kenney, J. H. Nichols, Nancy G. Roman, and R. M. Sloanaker.



This record of the strong radio source Cassiopeia A was made at a wave length of 10 centimeters. The telescope was set at the correct declination and the field of the source was allowed to drift across the antenna pattern.

QUESTIONS... FROM THE S+T MAILBAG

Q. Which are the five naked-eye planets?

A. The planets that can be seen with the unaided eye are Mercury, Venus, Mars, Jupiter, and Saturn. Uranus is at the threshold of visibility, and usually can be seen under favorable conditions if its position is known.

Q. How can I find the size of the field of view of my telescope?

A. If you know the apparent angular field of the eyepiece you are using, the true field of view is this number divided by the magnification. Another simple way is to set the telescope on an equatorial star (for example, one of the belt stars of Orion) and time its drift along a diameter of the field of view, the telescope being kept stationary. The eyepiece field in minutes of arc is equal to one-fourth the drift time in seconds.

Q. Can a satisfactory 8-inch telescope mirror be made from plate glass?

A. Yes, although plate glass is more sensitive than pyrex to temperature changes. The mirror should be at least 1⅛ inches thick, but 1½ inches is better, to avoid flexure effects.

Q. Are the same oculars that are used on small telescopes also used on large instruments of the same type?

A. Yes, they are exactly the same. However, it is usually not advisable to interchange the oculars for a refractor and a reflector. Huygenian eyepieces work better with the former, Ramsdens with the latter.

Q. Do I need a filter to view sunspots by projection?

A. No filter is needed when the sun's image is viewed projected on a card held behind the telescope eyepiece. But for safe direct observation of the sun through a telescope, a dense welder's filter is needed, and the telescope's aperture should be reduced to not more than two inches.

Q. What types of telescope can be recommended for serious planetary observing?

A. First-class refractors are excellent but costly, and good long-focus reflectors of at least 6-inch aperture are very suitable. However, reflectors of f/10 or longer require vibration-free mountings to be of much use.

Q. What is the current season on Mars?

A. According to the data in the *American Ephemeris and Nautical Almanac,* winter in the northern hemisphere of Mars began on August 15th, and spring will commence on January 21, 1959.

W. E. S.

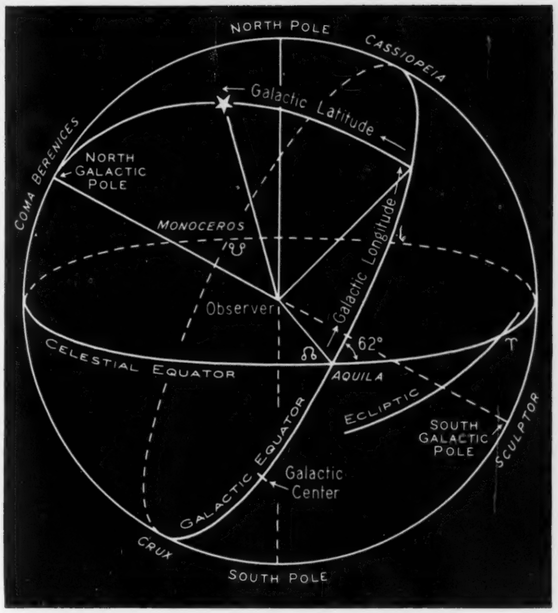
Galactic Co-ordinates

OTTO STRUVE, *Leuschner Observatory*
University of California

THREE YEARS AGO, at the Dublin meeting of the International Astronomical Union, a subcommittee of the commission on the structure and dynamics of our galaxy was charged with preparing recommendations for a revision of the system of galactic co-ordinates. This article concerns that problem.

The Milky Way appears in the sky as a fairly narrow, somewhat irregular band whose central line — the galactic equator — forms a great circle on the celestial sphere cutting the celestial equator at an angle of about 62 degrees. The crossing points are in Monoceros at right ascension about $6^h\ 40^m$ and in Aquila at about $18^h\ 40^m$. The north pole of the system of galactic co-ordinates is therefore near right ascension $12^h\ 40^m$, declination $+28°$, in Coma Berenices; the south pole, at $0^h\ 40^m$, $-28°$, is in Sculptor.

Galactic co-ordinates are expressed in galactic longitude and galactic latitude. The first is measured from the crossing of the celestial equator in Aquila, eastward and northward through Cassiopeia (galactic longitude 90°), to the crossing in Monoceros (180°); the southernmost part



The relationship between equatorial and galactic co-ordinates. (See the footnote on the next page.)

of the Milky Way is in Crux (270°). The center regions of the galaxy, in Scorpius and Sagittarius, have galactic longitudes of 320° to 335°. Galactic latitude is measured northward (toward Coma Berenices) and southward (toward Sculptor) from the galactic equator.

Some slightly different positions of the galactic north pole than that above have been used in times past. Sir William Herschel, in 1785, placed the north galactic pole at $12^h\ 24^m$, $+32°$, but in 1851 his son, Sir John Herschel, used $12^h\ 47^m$, $+27°$. Most of the research work at Harvard Observatory was based on the pole at $12^h\ 40^m$, $+28°$, and this was used by John Ohlsson in his very valuable co-ordinate conversion tables (Lund Observatory *Annals*, No. 3, 1932). But R. T. A. Innes and P. Emanuelli used $12^h\ 44^m.4$, $+26°.4$, for their work early in the 20th century.

It is not an easy matter to pin down the location and orientation of the galactic equator. As recently as 1941, in the first edition of their book, *The Milky Way*, Bart and Priscilla Bok wrote:

"We earnestly believe that there is much to be learned from a survey without the use of a telescope or photographic camera. Our eyes happen to be the finest pair of wide-angle binoculars that has yet been made. A telescope is useful in the study of fine details for comparatively small sections of the sky, but no instrument is capable of revealing the grand sweep of the entire Milky Way as well as the human eye."

Since that time, however, the Greenstein-Henyey camera has come into use (*Sky and Telescope*, July, 1951, page 215), and wide-angle photographs with this camera cover the whole sky. Not only do these pictures reproduce the naked-eye appearance of the Milky Way, but they show how much our galaxy resembles other spiral systems seen edgewise.

As Ohlsson had remarked, "The different investigations have given results which are in rather good conformity with each other. This also holds good of the earliest ones. On comparison between the different positions of the galactic pole, which have been obtained, it appears that the existing small differences may be mainly attributed to that circumstance that the position has been deduced from celestial objects of various types. It is obvious that a precise, definitively valid determination of the galactic plane, defined as the plane of symmetry towards which *all* objects of our Galaxy are concen-

The Milky Way from Aquila to Carina, photographed by A. D. Code and T. E. Houck in infrared light with a Greenstein-Henyey wide-angle camera. Note the distinct belt of obscuration, much as in an edge-on view of a spiral galaxy. From the "Astrophysical Journal," March, 1955.

trated, can never be made. Very likely we must content ourselves with defining a conventional position of the galactic pole."

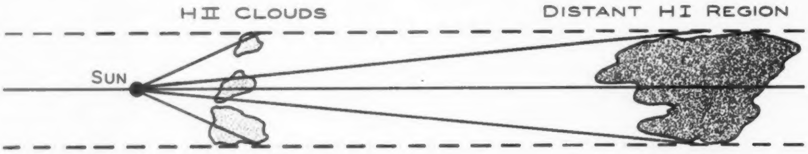
The original conversion tables of Ohlsson, using the epoch 1900, have recently been brought up to date. The revision makes allowance for the effect of precession from 1900 to 1958, but is based on the same system of galactic co-ordinates. However, investigations by J. J. M. van Tulder in 1942, J. Ashbrook and R. L. Duncombe in 1952, and T. S. Kirillova in 1955 indicate that the real pole of the Milky Way is on the order of a degree away from the pole used by Ohlsson.

A major breakthrough in the determination of the central plane of the galaxy has come from radio observations of the 21-centimeter radiation of neutral interstellar hydrogen. One of the members of the IAU subcommittee for the revision of galactic co-ordinates is a well-known radio astronomer, J. L. Pawsey of the Commonwealth Scientific and Industrial Research Organization in Australia. Together with C. S. Gum, he has compiled a report entitled "Radio Data Relevant to the Choice of a Galactic Coordinate System." This was to be submitted to the subcommittee at the Moscow general assembly in August, and was circulated simultaneously for the benefit of all astronomers interested in the subject.

Gum and Pawsey have amassed and discussed a vast amount of data which are in part still unpublished and are otherwise available only in detached form in many separate publications from a score or more observatories. It will therefore be of value to review here the conclusions of Gum and Pawsey, although these have undoubtedly had further consideration at the Moscow meeting.*

It has long been known that the Milky Way contains a layer of hydrogen; some of it, ionized by the ultraviolet light of hot stars, produces many of the luminous galactic nebulae. The hydrogen layer also coincides with the gaseous material that is observed by the interstellar absorption lines of neutral and ionized calcium, neutral sodium, ionized titanium, and other elements. Both the bright nebulae and the interstellar material are strongly concentrated toward the galactic plane. But the bulk of the hydrogen, composed of neutral atoms at the very lowest energy levels, is unobservable at optical wave lengths. At radio wave lengths, however, this neutral hydrogen produces 21-cm. radiation, the object of intense investigation by radio astronomers in many parts of the world.

*Added in press: At Moscow, the IAU voted that the system of galactic co-ordinates should be based on the neutral hydrogen distribution in the inner parts of the galaxy, and chose the galactic nucleus as the zero of galactic longitude.



Distant neutral hydrogen regions are better indicators of the galactic equator than are nearby ionized hydrogen clouds.

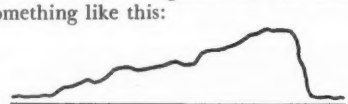
As expected, radio telescope surveys of the sky at 21 centimeters show conspicuously the effect of hydrogen concentration toward the central plane of the galaxy. In this work the radio observations have an enormous advantage over optical studies of the gaseous layer. The latter are limited to relatively short distances from the solar system. On the other hand, hydrogen 21-cm. emission is not absorbed by interstellar dust; it can be observed at practically all distances. Hence, the angle subtended by very distant neutral hydrogen regions is much smaller than that over which we see the most distant observable ionized hydrogen clouds. Thus, a small error in determining these angles produces for the optical observations a much greater uncertainty in defining the central plane than it does for the radio observations.

The data discussed by Gum and Pawsey have been obtained with the Leiden and Sydney radio telescopes. Located in Holland and Australia at latitudes 52° north and 34° south, respectively, they cover between them the entire circuit of the Milky Way. There is a considerable overlap of the two series of observations.

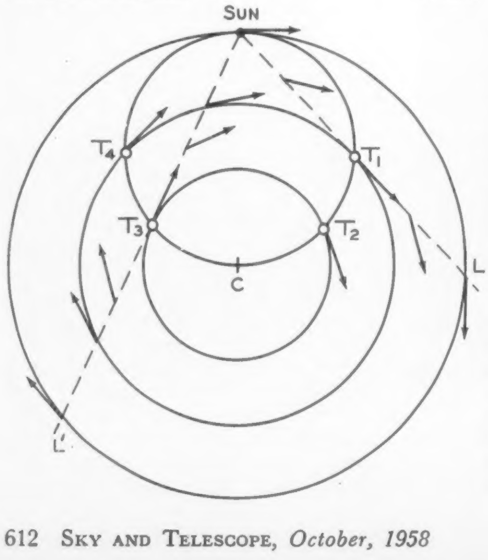
The optical data used by van Tulder for the determination of the galactic pole are represented in one diagram by the circle surrounding the sun at a distance of about 3,000 parsecs. Of particular significance are *tangential points* (marked in the diagram below with open circles for actual radio observations). **L** and **L′** indicate lines of sight from the sun across interior regions of the galaxy.

Consider **L** first, passing through the entire mass of neutral hydrogen in this particular galactic longitude. The arrows indicate the direction of rotation at points along this line of sight. In the vicinity of the sun the line-of-sight components of the rotation are small, and the radiation received from such points has only a small Doppler shift toward the red (motion of recession). Such shifts increase to a maximum at T_1, where the motion is directed fully away from the sun, but beyond that distance they decrease again.

If we obtain a tracing of a profile of the 21-cm. line at longitude **L**, we obtain something like this:

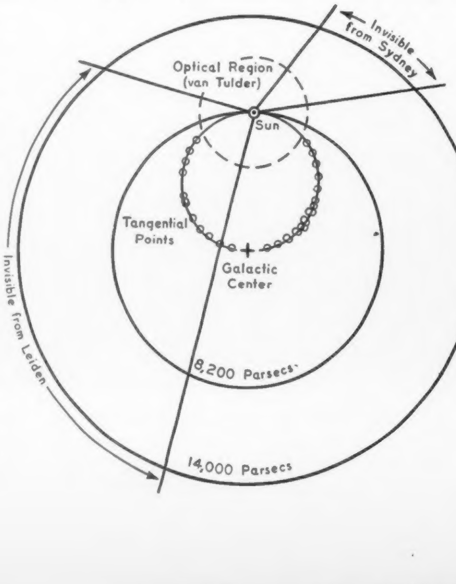


At another galactic longitude, such as **L′**, similar tracings are obtained, except that in this case the Doppler displacements are toward the violet (motion of approach), and the maximum is at T_3. Be-



Left: In this schematic representation, hydrogen clouds are assumed to have equal circular motions around the galactic center. As seen from the sun, however, their line-of-sight velocities are different, reaching maxima at the tangential points (open circles).

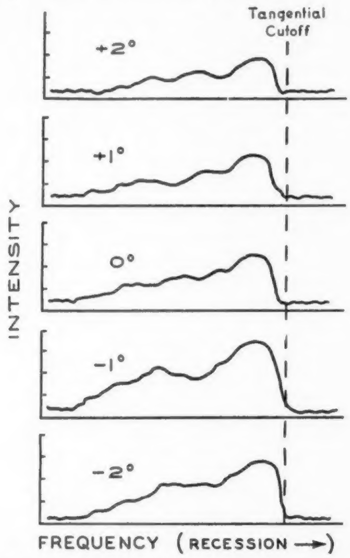
Right: In the Gum-Pawsey report, the assumed distance of the sun from the center of the galaxy is 8,200 parsecs, and the outer regions lie about 6,000 parsecs beyond the sun.



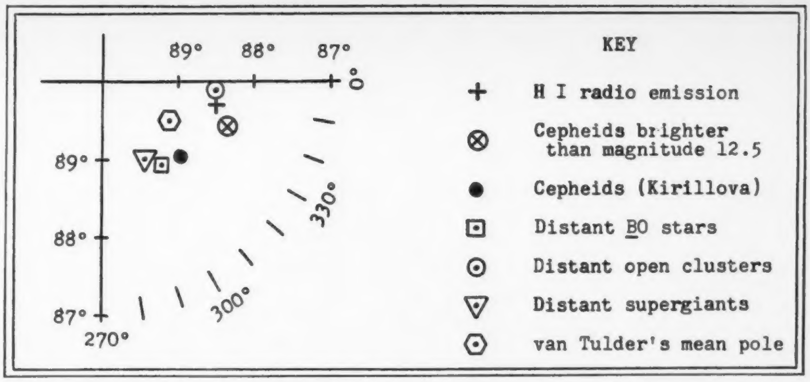
cause they are tangent to circles of definite distances from the galactic center, **C**, points T_1 and T_3 are called tangential points. On these same circles T_4 and T_2 have the same respective maximum Doppler shifts.

The locations of all possible tangential points define the circle around a point midway between the sun and the galactic center, its diameter being adopted as 8,200 parsecs by Gum and Pawsey (some astronomers prefer larger values; for example H. F. Weaver is using 10,000 parsecs). It is on the basis of the tangential points that radio astronomers have been able to construct models of the distribution of hydrogen gas in the plane of the galaxy.

But what about the thickness and orientation of the hydrogen layer? Let us suppose that in each galactic longitude we obtain tracings at several galactic latitudes, that is, above and below the galactic equator. At **L** we might record the 21-cm. radiation at latitudes $+2°$, $+1°$, $0°$, $-1°$, and $-2°$. The five tracings might look schematically like this:



It would be evident at once that the radiation is most intense at latitude $-1°$ and not at $0°$, from which we would infer that in this longitude the real plane of the hydrogen layer must be one degree south of the conventional (and incorrect) equator. We can thus, step by step, find the location of the true plane of the galaxy with respect to the equator adopted by Ohlsson.



Some recent determinations of the galactic pole from distant objects are charted here, with the galactic longitude and latitude scales corresponding to Ohlsson's pole. The latter, at the intersection of the co-ordinate axes, is evidently more than a degree in error.

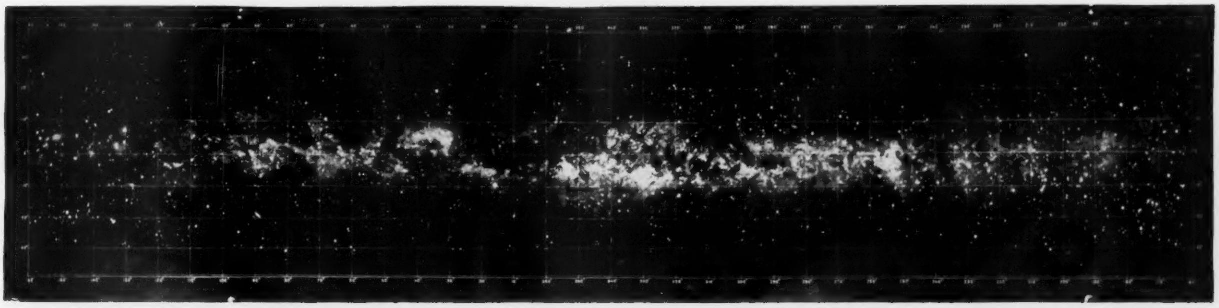
But, for all we know, the hydrogen layer determined in this manner may not be entirely flat. We may find, for example, that at T_1 the maximum intensity is a degree south of the galactic equator, at T_2 it is half a degree south, and at T_3 $1\frac{1}{2}$ degrees. Since we know the relative distances from us of the tangential points, we can easily compute in parsecs just how much the region of maximum intensity departs from the true average plane. We can also determine whether this average plane forms a great circle on the celestial sphere, implying that the sun lies in the plane itself, or that it does not and that the sun is a number of parsecs above or below this plane.

The most accurate results of this investigation were obtained by Gum and F. J. Kerr, as reported in an as yet unpublished paper, based on Sydney observations and Leiden data furnished by G. Westerhout. In terms of Ohlsson's co-ordinates, the pole of the true hydrogen plane is at galactic longitude 348°, at a distance of 1.6 degrees in galactic latitude from Ohlsson's pole. The sun lies in the principal plane of the galaxy, with an uncertainty of about 20 parsecs, while the local departures from the plane are nowhere greater than 25 parsecs. In equatorial co-ordinates, the true pole of the hydrogen plane is at $12^h\ 49^m.4$, $+27°\ 23'$ (epoch 1950).

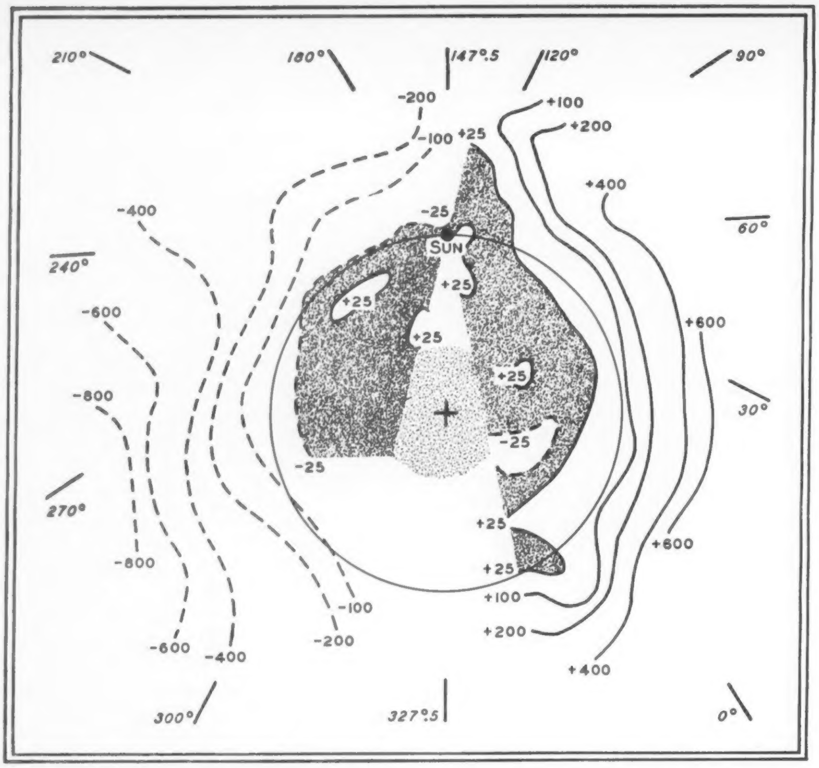
As the chart shows, the conventional pole is incorrect, for the pole defined by the plane of the hydrogen gas practically coincides with that indicated by the galactic concentration of the most distant objects considered by van Tulder, as well as the Cepheids at the greatest distances for which Ashbrook and Duncombe considered their data relatively complete. It is important to bear in mind, however, that these radio results refer only to the inner portions of the Milky Way, that is, to distances no greater than 8,200 parsecs from the center of the galaxy.

Thus, in the inner regions, the hydrogen gas appears concentrated into a remarkably flat and thin layer, and the position and orientation of this disk may be found with a high degree of precision. In the outer regions, however, the hydrogen layer is systematically distorted, having significant departures from flatness, according to additional radio observations discussed by Gum and Pawsey.

At points in the galaxy farther out from the center than the sun is, we have no tangential points with which to identify the Doppler shift cutoffs. Therefore, the determination of the average hydrogen plane, and of its local departures, is more difficult. We must resort to the assumption of a "force law" in the Milky Way, as found from optical observations of differential galactic rotation. For in-



The full length of the Milky Way, drawn by O. Jahnke according to Harvard Observatory photographs by S. I. Bailey. In this picture, Scorpius and Sagittarius are in the middle while Auriga is on either end.



This contour map shows heights in parsecs of the neutral hydrogen layer above and below the galactic plane. The hydrogen within the sun's distance from the center lies very close to the plane, forming a "hydrogen plateau." At greater distances, however, most of the hydrogen lies well above or below the plane. Light shading indicates the region of the galactic hub.

stance, if all the mass of the galaxy were at the center, this law becomes equivalent to Kepler's laws of planetary motion.

Although there is still some uncertainty about the exact form of the actual law, we may use the best available approximation and *compute* the Doppler shift that corresponds to a given galactic longitude and distance from the sun. The observed Doppler shifts for a particular 21-cm. profile can then be associated with definite distances. In this manner, we can approximately compute the departure in parsecs from the central hydrogen plane at many different points, by means of intensity tracings made at several galactic latitudes (for each galactic longitude and Doppler shift combination), just as we did for the tangential points in the interior region of the galaxy.

Gum and Pawsey present their results in two charts, each of considerable significance. The first is a kind of contour map, showing the central "plateau" or flat region of the hydrogen layer, and on either side the increasing departures from it. On the left side the hydrogen layer extends as much as 800 parsecs south of (below) the central plane, and on the right side it is up to 600 parsecs north.

The second chart is a plot of the data on the basis of distance from the galactic center, Leiden observations on the right side and most of the Sydney results on the left. The tangential points are indicated by the filled and open circles, all other points by small dots. Although the general points of the interior region have been included for Leiden, those for Sydney have been omitted because they require more detailed analysis, now being done by Kerr.

A simplified way to interpret these results is to say that a cross-section of the Milky Way hydrogen, extending through the galactic center and at right angles to the line joining the center and the sun, looks like a greatly elongated, horizontal letter *S*, while along the line joining sun and center the hydrogen cross-section is practically a straight line.

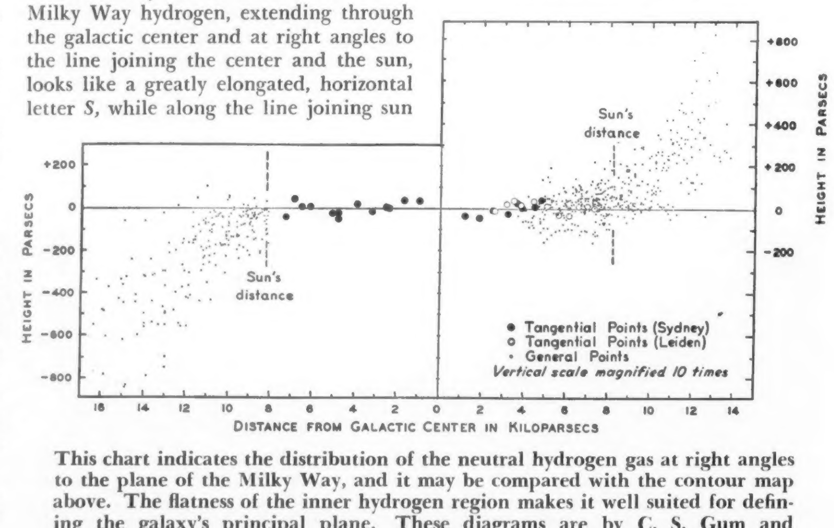
It may be somewhat disturbing that the buckling of the hydrogen layer appears to be related to the position of the sun. But the 21-cm. radio observations can give us no information in a large cone whose axis runs from galactic longitude 147°.5 to 327°.5, because the components of differential rotation in the line of sight are indistinguishable from each other. There may also be some uncertainty arising from the adopted distance to the center and the adopted force law.

A considerable part of the report by Gum and Pawsey concerns radio observations of the Milky Way at other wave lengths than the 21-cm. hydrogen line. These consist of surveys of the sky with antennas of various beam-widths, some as wide as 25 degrees, some as narrow as 0.57 degree. In each case a band of frequencies in the radio continuum was recorded, the greatest frequency being 1,400 megacycles per second, the lowest, 38 megacycles. The Australian astronomers conclude:

"The data now available are therefore consistent with the hypothesis that the large-scale spatial distribution of the continuum sources is coincident with that of the neutral hydrogen, the surfaces of maximum density of both being flat in the inner regions of the galaxy, and systematically distorted in the same way in the outer parts. (This result implies some type of physical interdependence between the neutral hydrogen and the continuum sources. Such studies may therefore help to elucidate problems connected with the theory of the origin of the continuum radiation.)"

An important part of the co-ordinate revision problem is determining the direction toward the center of the galaxy. In 1952, J. H. Oort compiled this list of positions determined by optical methods,

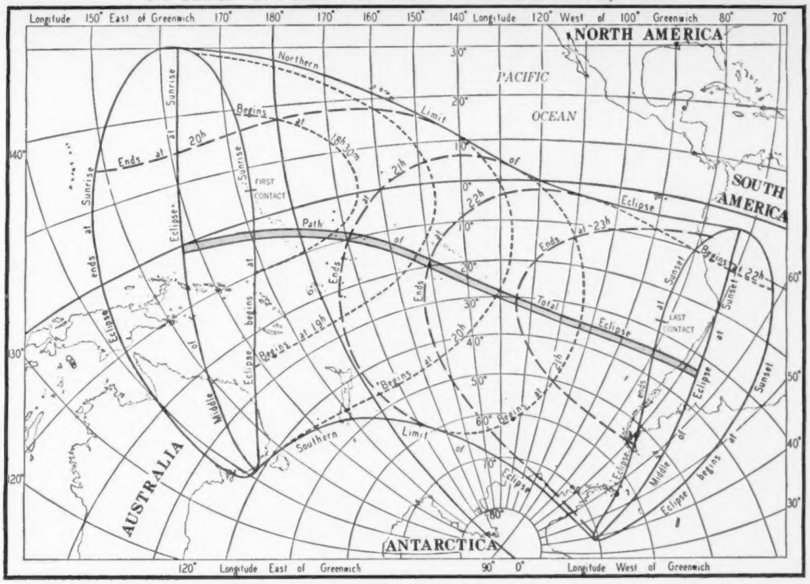
(*Continued on page 617*)



This chart indicates the distribution of the neutral hydrogen gas at right angles to the plane of the Milky Way, and it may be compared with the contour map above. The flatness of the inner hydrogen region makes it well suited for defining the galaxy's principal plane. These diagrams are by C. S. Gum and J. L. Pawsey, taken from their report, "Radio Data Relevant to the Choice of a Galactic Coordinate System."

A Total Eclipse of the Sun

TOTAL ECLIPSE OF OCTOBER 12, 1958



The path of totality lies entirely in the Southern Hemisphere, while the partial phases of the eclipse will be visible over a wide region of the Pacific Ocean and parts of Australia, South America, and Antarctica. From the "American Ephemeris and Nautical Almanac."

EIGHTEEN YEARS AGO, on October 1, 1940, the path of a total eclipse of the sun crossed the northern part of South America, maximum totality lasting five minutes, 35 seconds. The interval of an eclipse saros, 18 years and 11 days, has elapsed since then, and the next eclipse in the saros series will occur October 12, 1958, with a maximum totality of five minutes, 11 seconds.

The belt of totality and the extent of the partial phases are shown in the map from the *American Ephemeris.* In spite of its great length, the path of totality crosses land only at eight islands in the South Pacific Ocean and in Chile and Argentina. Most eclipse expeditions will be established among the Pacific islands, but the eclipse may be seen by very many people in South America, although it takes place near sunset.

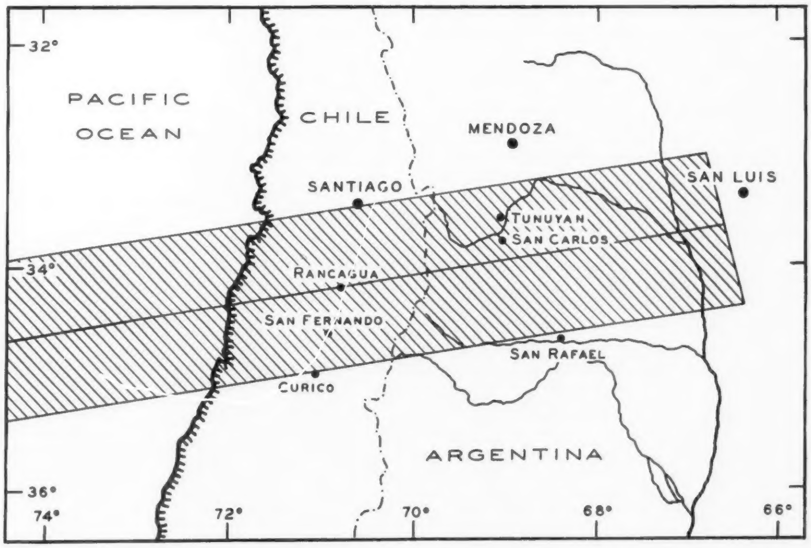
Santiago, the capital city of Chile, lies mostly within the northern edge of totality, and the astronomical observatory of the University of Chile will view a total phase lasting 1.4 minutes, weather permitting. The central line passes over the town of Rancagua, where totality will be 2.4 minutes long. Several other large places lie within the path, and a number of smaller communities.

The accompanying chart is adapted from a comprehensive review of the circumstances of the eclipse published by the University of Chile. It was compiled by Adelina Gutierrez Alonso of the observatory staff. Because the eclipse occurs near sunset, Senora Gutierrez found it necessary to use the method of successive approximations, instead of the conventional formulae, to calculate the northern and southern limits of the path in South America.

The month of October, coming in early spring in the Southern Hemisphere, is one of considerable cloudiness in Chile, so the chances of favorable observation so near sunset are only fair. Nevertheless, weather records at a number of places in the path of totality show that about one third of the days in October are clear, and the average number of rainy days is only four.

Sky and Telescope has published a number of articles dealing with the October 12th eclipse, chiefly describing the Pacific islands in the path of totality and the expeditions that will observe from them: October, 1956, page 538; October, 1957, page 573; June, 1958, page 395; July, 1958, page 450; and August, 1958, page 499.

An interesting addition to American plans to observe this eclipse from the Danger Islands has been announced by the National Academy of Sciences. David Morrison, an 18-year-old amateur astronomer from Danville, Illinois, has been selected to accompany the American expedition. Mr. Morrison was nominated for the honor by the Astronomical League; the trip is part of the academy's program of stimulating a wider interest in science on the part of the nation's youth.



This map is adapted from "El Eclipse Total de Sol del 12 de Octubre de 1958," by Adelina Gutierrez Alonso, published by the University of Chile's faculty of physical sciences and mathematics. Rancagua, directly on the central line of totality, is well placed for observations.

Albert (Unk) Ingalls and Russell W. Porter at Stellafane in August, 1937, the two men most responsible for the growth of amateur telescope making. Mr. Ingalls, at another Stellafane meeting, is pictured on the front cover. All photographs by the author.

Albert G. Ingalls, T. N.

ROBERT E. COX, *Amateur Telescope Makers of Boston*

TELESCOPE MAKING'S leading exponent, Albert G. Ingalls, died on August 13th at the age of 70. For about 30 years thousands of amateurs had followed his articles and column in *Scientific American* magazine, and to many their "bible" was the book *Amateur Telescope Making,* which he edited.

"Unk" Ingalls, as he signed all his correspondence, was an adviser and godfather to all the amateurs who read his column and formed local telescope making groups. The writer received sage advice from him in the middle 1930's, when a number of amateurs in New York City were trying to keep their telescope making group alive under difficult workshop conditions. We later became the Optical Division of the Amateur Astronomers Association, with our shop in the basement of the Hayden Planetarium. Similar advice by Ingalls to other clubs has helped them over the rough spots of getting started.

He was proud of his self-imposed degree of T.N., Telescope Nut, which, as he pointed out in his column many years ago, is automatically attained whenever an amateur completes his first mirror. One's neighbors may not appreciate the urge to go down in a cellar night after night, rubbing two pieces of glass together until a mirror results, nor the urge to observe with the finished telescope despite cold and fatigue. Ingalls' inspiration led many hobbyists to join the fraternity of telescope makers, regardless of the opinions of their families and neighbors.

He graduated from Cornell University in 1914, served in France in World War I, and joined the *Scientific American* staff in 1923. Having an interest in making his own telescope, he encouraged contributions from the readers, publishing letters and descriptions of amateur instruments. An occasional feature story he signed as "The Telescope Editor," and in 1926 he published *Amateur Telescope Making.*

The first printing of this book had 102 pages; the 1956 edition has 497 pages, and there are two thick companion volumes, *Amateur Telescope Making – Advanced* and *Amateur Telescope Making – Book Three.* The contributions assembled by Ingalls in these three volumes are of high caliber, and they are found on the reference shelves of most large optical shops.

On page 244 of the March, 1928, *Scientific American,* the following announcement appeared:

"Beginning with the next issue, the SCIENTIFIC AMERICAN will contain regularly a special page devoted to the amateur telescope maker, under a humorous heading sketch drawn by the original mentor of the amateur, Russell W. Porter of the 'Telescope Makers of Springfield,' Vermont, and reproduced above in miniature. We amateur telescope makers now number over 3000, and the hobby continues to spread. It is time we had our own 'back yard' to play in. In the new department we shall discuss, not astronomy itself but *telescope making,* an amateur art which it is plain to see is here to stay. Astronomy itself is amply covered in our columns by Professor Russell's monthly articles. The new department for the telescope maker will be conducted informally and in the shop talk of the amateur enthusiast.

– The Telescope Editor."

The column actually began in May, entitled "The Back Yard Astronomer," and in July was signed with the initials *A. G. I., Tel. Ed.* In about a year the title was changed to "The Amateur Astronomer," about six years later to "The Amateur Telescope Maker." The title "Telescoptics" was used from 1937 to 1948, but during all this time the caliber and contents of the department remained the same, having a tremendous influence in bringing the hobby of telescope making to its present proportions.

Letters from Ingalls were unique in their content and noted for their pixy sense of humor. The writer once received

Mr. Ingalls checks the figure on a mirror at the knife-edge tester of the Optical Division, Amateur Astronomers Association, May, 1937. Two writers of articles in the "Amateur Telescope Making" series of books, which Mr. Ingalls edited, are at the left: J. R. Haviland and Earle B. Brown. At the right are Jim Grant and the author, members of the Optical Division.

one addressed: "Cox and Box, Deep in the Basement of the Hayden Planetarium," and was thus introduced to the famous Morton farce of 1847. It was finally decided that "Box" was another member of the Optical Division, Lou Lojas, now a professional optician.

A shy, retiring man, Unk was difficult to persuade to attend a public function, let alone to speak before an audience, though he did appear frequently at the get-togethers at Stellafane. Sometimes he stayed in a little cabin off in the woods there, and I spent many pleasant hours discussing optics with him. His vacations were taken at his hermitage on Seneca Lake, New York, reading and meditating. But always he kept up his correspondence with telescope makers.

Ingalls was respected as a scientific editor, and received the Blair medal of the Western Amateur Astronomers, the Astronomical League award, and other honors. During World War II, he organized the work of amateur telescope makers to help overcome the shortage of roof prisms for military instruments.

In June, 1955, Ingalls retired to his home in Cranford, New Jersey, after almost a third of a century of service to *Scientific American*. With his death, the last of the big three behind the amateur telescope making movement in America has passed away. The others were Russell W. Porter (*Sky and Telescope*, April, 1949, page 143), and John M. Pierce (June, 1958, page 407).

A typical scene at a Stellafane convention, with Mr. Ingalls discussing problems in telescope making with his fellow amateurs.

GALACTIC CO-ORDINATES

(*Continued from page 614*)

which is included in Gum and Pawsey's report:

Observing Method	*Galactic Longitude*
Star counts in intermediate latitudes	324° ± 5°
Star counts in high latitudes	335° ± 5°
Globular clusters (Shapley)	325° ± 3°
Planetary nebulae (Minkowski)	328° ± 3°
Infrared radiation (Stebbins and Whitford)	326° ± 2°

What about radio observations of the direction of the galactic center? These are complicated by a strong source of continuous (not 21-cm.) radiation which is known as Sagittarius A or 17S2A. In 1955, R. X. McGee and J. G. Bolton suggested that this source might be the actual nucleus of our galaxy, but this question is still controversial. Gum and Pawsey write:

"The most cogent evidence on the distance appears to be that of van Woerden, Rougoor and Oort (1957). They found absorption of 21-cm. radiation from 17S2A in a spiral arm which showed a velocity of approach of 50 kilometers per second. Because of the high velocity they considered it must lie within a distance less than about 2.5 kiloparsecs from the galactic centre. A second arm, this time with a velocity of recession and presumably on the side of the galactic centre remote from the sun, showed no absorption. . . . These observations place the source 17S2A definitely between the two arms and hence presumably nearer to the galactic centre than 2.5 kiloparsecs."

Narrow-beam radio surveys place Sagittarius A in a position close to that of the galactic center, Gum and Pawsey computing a weighted average from the observations of many investigators: longitude 327°.74, latitude −1°.46. Other radio continuum determinations of the longitude of the center, with the influence of 17S2A removed, are:

Investigators	*Beam-Width*	*Longitude*
Bolton and Westfold	17°	328°±3°
Allen and Gum	25°	328½°±3°
Piddington and Trent	3°.3	328°±4°
Hill, Slee, and Mills	0°.8	327½°±2°

The average of these radio continuum positions is 328° ± 1°, while that of the optical observations given above is 327° ± 1°. The Sagittarius A weighted average lies between these values. We conclude with the authors:

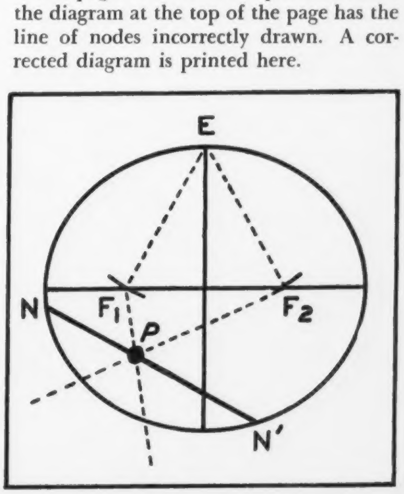
"Thus the source 17S2A appears to be at approximately the distance of the galactic centre; it agrees in direction well within experimental uncertainty with that of the galactic centre; and it is one of the strongest sources in the Galaxy. The balance of evidence appears to be in favour of identifying the source 17S2A with the galactic nucleus."

This conclusion has recently been verified by studies described at the Paris symposium on radio astronomy and reported by Bart J. Bok on page 622 of this issue.

The discovery of this mysterious source of continuous (and perhaps nonthermal) radio radiation in the center of the Milky Way constitutes one of the most challenging results of modern astronomy. We can observe it in radio frequencies because of the transparency of interstellar space to long-wave radiation. Perhaps we can even hope to observe it optically with infrared filters. Indications that this may be possible have been obtained photoelectrically by American and Russian observers, and W. Baade has sometimes spoken of some kind of "supercluster" at the centers of spiral galaxies. There may also be some connection between the Sagittarius A source in the Milky Way and C. K. Seyfert's observations of intense and exceedingly broad Balmer emission lines in the spectra of the nuclei of very distant spirals.

CORRECTION TO DIAGRAM

On page 551 of the September issue, the diagram at the top of the page has the line of nodes incorrectly drawn. A corrected diagram is printed here.



IC 5152 is well resolved into stars of the 18th magnitude and fainter, with a few probable emission objects that are brighter. This one-hour exposure was made in blue light on an Eastman 103a-O plate on October 22, 1954. The scale is 2.9 seconds of arc per millimeter.

Among Southern Galaxies—IX

PICTURED ABOVE is IC 5152, which is either a large spiral of very late type or an irregular Magellanic-type system. It is located in Indus, at right ascension $21^h\ 59^m.6$, declination $-51°\ 32'$ (1950 co-ordinates), some 52 degrees from the galactic equator.

The Skalnate Pleso *Atlas of the Heavens* contains this object, near the Indus-Grus border. Though probably a part of the Pavo-Indus cloud of galaxies, IC 5152 may be an outlying member of the nearer group of spirals in Grus.

Gerard de Vaucouleurs lists the photographic magnitude as 11.3, and assigns this galaxy a classification of SA(s)dm or IAm in his new system, described on page 582 of the October, 1957, *Sky and Telescope*. The dimensions of the bright inner parts are 3.5 by 1.6 minutes of arc, though extensions can be traced to 4.6 by 2.9. The brilliant foreground star, HD 209142, is of photographic magnitude 7.8.

The galaxy is resolved into stars of the 18th magnitude and fainter, and these are much bluer than the core of the system. Some brighter patches are probably emission objects. The Doppler red shift of the spectrum of IC 5152 is unknown, but it is presumably a fairly nearby galaxy.

The adjoining picture shows NGC 7098, in the constellation of Octans only 15 degrees from the south celestial pole, at $21^h\ 41^m.4$, $-75°\ 20'$; this is about 38 degrees from the central line of the Milky Way. The Hubble classification is SBb, while Dr. de Vaucouleurs calls it an early-type spiral, assigning (R)SAB(rs)a.

The magnitude, distance, and red shift of NGC 7098 are unknown. This one-hour blue-light exposure with the 74-inch reflector was made on June 12, 1956. Here the scale is 2.9 seconds of arc per millimeter.

David S. Evans points out that NGC 7098 is at first sight an insignificant elliptical nebula, 0.4 minute of arc long, but that closer inspection reveals its barred structure, consisting of a band of luminosity with two "wing-tip" bright patches. Around this there is a faint oval and, still farther out and recorded on the negative though not shown here, a heart-shaped zone of extremely faint luminosity. The total dimensions are about 4.7 by 2.8 minutes.

Dr. de Vaucouleurs notes that the patches at the extremities of the bar are characteristic of many early barred spirals of the transition type (rs). This object is not listed in the Shapley-Ames *Catalogue,* and very little is known about it.

This month's feature picture is of NGC 1515, on the Dorado-Reticulum border at $4^h\ 02^m.7$, $-54°\ 14'$, about 45 degrees from the galactic plane. This galaxy resembles the famous Great Nebula in Andromeda, M31, and is of the same Hubble type, Sb. The de Vaucouleurs classification is SA(s)b, as shown by the smaller-scale picture on page 585, October, 1957, issue.

The Shapley-Ames integrated magnitude is 12.1, but the radial velocity is unknown. In size, NGC 1515 measures about 5.8 by 1.2 minutes of arc.

Close by on the western side of this galaxy is a complex barred spiral of type SBb, but it is not listed in the *New General Catalogue* or in either *Index Catalogue.* The faint arms of the system extend outward more than one minute of arc and have considerable complexity.

Eight other readily identifiable galaxies and many fainter objects are seen in this photograph. The region is included in Shapley's Horologium catalogue (Harvard *Annals 88,* No. 5, 1935), but it is difficult to reconcile the list with the field as shown here.

FACING PICTURE: The great spiral galaxy NGC 1515, photographed with the 74-inch telescope of the Radcliffe Observatory at Pretoria, South Africa. This one-hour exposure, on October 23, 1954, was made in blue light, on an Eastman 103a-O plate without a filter. The reproduction scale is about 2.2 seconds of arc per millimeter. North is at the top, east to the left. Also in this field is a complex barred spiral to the right of NGC 1515, and many other fainter galaxies.

These three pictures are more from the Cape Photographic Atlas of Southern Galaxies, which began in the February, 1958, issue. They are being reproduced by permission of R. H. Stoy, director of the Royal Cape Observatory, Cape of Good Hope, Union of South Africa.

The Paris Symposium on Radio Astronomy

BART J. BOK, *Mount Stromlo Observatory, Australian National University*

BETWEEN July 30th and August 6th, about 200 radio astronomers from all over the world met in Paris, France, at a symposium organized jointly by the International Astronomical Union and the Union Radio-Scientifique Internationale (URSI), the organization responsible for the world-wide co-ordination of radio astronomy research.

Local arrangements for the symposium, held at beautiful Cité Universitaire, were capably handled by J. F. Denisse and his staff from Meudon Observatory and its radio astronomy station at Nancay. J. L. Pawsey of Sydney, Australia, and F. T. Haddock, University of Michigan, were respectively chairman and secretary of the organizing committee. R. N. Bracewell, Stanford University, will edit the proceedings of the symposium.

The growth of radio astronomy may be measured by the steadily increasing size of its symposia—50 persons at the 1953 meeting in Manchester, 100 there in 1955, and 200 present in Paris. But radio astronomy is still a young science, whose workers feel the need to meet once every two or three years to compare notes on progress — and the lack of it at times! Moreover, these symposia bring together scientists of widely different backgrounds, including radiophysicists, electronic engineers, and astronomers.

However, as the pioneer days of radio astronomy pass by, we are beginning to realize that radio and optical astronomy are not separate, but are integral parts of the study of the universe. The aims of both are identical, differing only in basic techniques. Hence, within the next decade we shall probably move toward symposia dealing comprehensively with solar or planetary research, or the Milky Way and galaxies, where the radio astronomer will mingle in a natural manner with his colleagues in optical research.

Since the Paris organizing committee divided the subjects of the symposium into six major categories, we shall follow approximately that arrangement in this review.

Moon and Planets

Startling progress was reported in radar observations of the surface of the moon. With the aid of techniques developed in Washington, D. C., by the Naval Research Laboratory and in Great Britain, signals can now be transmitted to the moon and echo pulses received with such precision that distances may be estimated within one-fifth of a mile. Since the echos reach us from a rather small central area of the lunar surface, the possibility exists of studying some of the moon's topography by radar methods.

Other interesting results include the confirmation, by studies of reflection percentages, that the moon is covered with a two-centimeter layer of dust, and a value for the upper limit of the density of a lunar atmosphere, if one exists (*Sky and Telescope,* November, 1957, page 12).

Perhaps most exciting was the announcement by A. C. B. Lovell, director of the Jodrell Bank Experimental Station, Manchester, England, that the giant 250-foot reflector is to be used to bounce radar signals off Venus. If this experiment is successful, we shall not only be able to measure the Earth-Venus distance accurately, but we should gather useful information concerning the rate of rotation of Venus on its axis (see page 547, September issue).

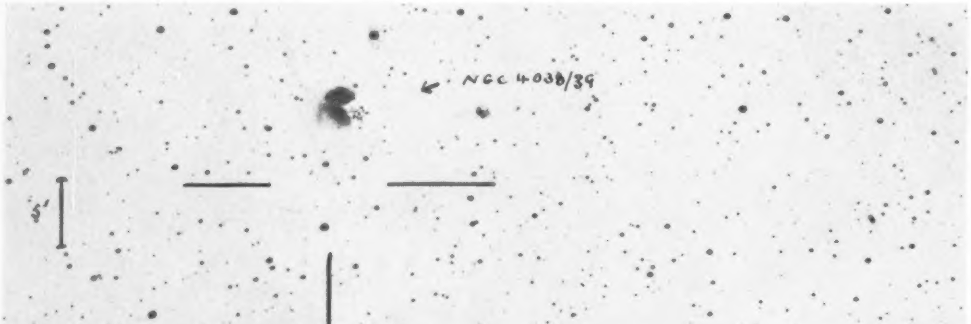
The study of radio emission by the planets continues. There were several papers about bursts from Jupiter and Saturn (at long radio wave lengths), but no confirmation of those reported some years ago for Venus. These bursts apparently originate at the surfaces of the planets. The term "volcanic activity," hardly more than an inspired guess, continues to be mentioned in this connection.

In the millimeter and centimeter ranges, new receiver techniques, particularly those of NRL in collaboration with Columbia University, enable very precise measurements of thermal radiation emitted by the planets, notably Venus. The derived temperatures are somewhat higher than those expected from optical data.

The Sun

The classification of solar radio phenomena was described by our host, Dr. Denisse. He was followed by C. de Jager of Utrecht Observatory, Holland, who summarized theories on the structure of the chromosphere and the lower corona. The conclusions of this session were reviewed by M. Minnaert, also of Utrecht.

De Jager and others see the chromosphere as a transition region between the photosphere and the corona. Turbulent currents from the photosphere ascend into the chromosphere. This transfer of



On this working print of a negative taken with Uppsala Observatory's Schmidt telescope at Mt. Stromlo, Australia, three ink lines mark a strong radio source. It seems identical with the complex galaxy NGC 4038-39, which R., Minkowski believes to be two galaxies in collision. See page 166 of the February, 1957, issue for a Palomar Observatory photograph of this object. In the lower right is NGC 4027, another peculiar galaxy.

mechanical energy heats the chromosphere, producing its mottled appearance and the spicules. As the currents move upward, the energy dissipation lessens, but in the highly rarefied corona the transferred energy exceeds the amount lost by radiation from the gas. This gives rise to the characteristic coronal temperatures of a million degrees or so, but the corona still emits less than 10 per cent of the energy flux entering it from below. A part of the remainder propels high-speed particles into space, while the balance is conducted backward to help smooth the temperature gradient between the corona and the chromosphere.

Solar radio emissions at centimeter wave lengths, originating largely in the lower chromosphere, generally show a very close correlation with optical phenomena. At Sydney, R. G. Giovanelli and his group provide optical data to supplement 20-centimeter radio observations by W. N. Christiansen and his associates, who use crossed multiple interferometers, called *Chris-crosses*. With such devices, they can locate on the sun radio emission sources to within three minutes of arc (one-tenth the solar diameter).

Another Sydney development, J. P. Wild's radio sweep-frequency spectrograph, is furthering the study of solar bursts. The Sydney instrument – and its northern counterparts at Ft. Davis, Texas (page 388, June issue), and the University of Michigan – provide records of solar bursts which, as they rise into the sun's atmosphere, transmit radio radiation at the wave length characteristic of a particular level.

There was much discussion about the particular manner in which radio bursts originate. Some may be caused by streams of particles or shock waves, but magnetic fields seem to play an important role in the more extreme cases. Studies of radio polarization phenomena may help in this problem. Much interest was expressed in the work being done by Russian astronomers along these lines.

Discrete Sources

Since 1946 we have known that discrete radio sources exist in the sky. A few of these have been identified with optical objects, but the majority have not. The search for these radio sources and the precise mapping of the radio sky are not simple matters. Since the 1955 symposium, there has been considerable discussion of the differences in the surveys conducted at Cambridge, England, and in Australia (*Sky and Telescope,* December, 1957, page 61). Many checks have been made, and this writer feels the decision is in favor of the Australian survey.

In both of these surveys interferometer-type antenna systems were used. Some experts believe that interferometers yield positions of higher precision for the brighter sources than do pencil-beam instruments, but that the former probably

A rich field of unusual filamentary nebulosity marks the neighborhood of a very strong radio source two degrees in diameter, centered (upper right) on $8^h 34^m.0$, $-45° 39'$ (1960 co-ordinates). South is at the top, and the reproduction scale is about one third of a degree to an inch. This is part of a 75-minute exposure in red light, which was obtained with the Uppsala Schmidt telescope at Mount Stromlo Observatory.

miss the extended radio sources. P. A. G. Scheuer suggested that interferometers may be able to give useful information regarding the distribution of faint and now undetectable sources, but experts are not agreed. The safest course for the future seems to be to concentrate on pencil-beam surveys, with two or three separate instruments of great size (such as the Jodrell Bank 250-foot dish) checking each other's results.

To the sorrow of the cosmologists present, the observers were fairly unanimous in recommending caution and a conservative approach in attempting to build relativistic cosmologies on the basis of the available data on the number and distribution of radio sources. The best data now give little indication of any significant deviation from a uniform distribution in depth for faint sources, most of which are certainly of extragalactic origin.

B. Y. Mills suggested several years ago that there are two varieties of radio sources. Class I includes those within the Milky Way galaxy, while Class II contains the remote galaxies. The galactic emitters are of two types. The first, such objects as the Orion nebula, emit simply because of the high temperatures in dense interstellar clouds. The second, according to R. Minkowski, are all probably remnants of supernovae (*Sky and Telescope,* January, 1958, page 116). These radiate in a nonthermal fashion through a process, outlined in our concluding section on theoretical work, which requires the presence of a powerful magnetic field. The thermal sources are strongest at high frequencies, where supernovae remnants are generally undetectable, whereas the nonthermal ones are prominent at low frequencies. The majority of Class II sources, remote galaxies, probably have a nonthermal spectrum.

For further interpretation, we need as detailed information as possible about the well-documented radio sources, not only such an object's radio flux or brightness, but its polarization, variation of brightness over a wide range of frequencies, precise position, and distance. The conference received assurance that distance estimates would become available before long, either from the study of effects caused by the expansion of the universe or, for galactic objects, from 21-cm. absorption studies.

Considerable attention was paid to problems of optical identification of radio sources. D. W. Dewhirst of Cambridge, England, has been working with Minkowski at Pasadena; in Australia, Mills at Sydney and J. Basinski, K. Gottlieb, and the writer at Mount Stromlo have been active. Despite considerable effort, however, few new identifications have been made.

Especially significant was a joint report from Columbia University and NRL telling of the first application to radio source studies of the device called the *maser* (microwave amplification by stimulated emission of radiation), which was described in this magazine in March, 1958, page 234. As seen on the next page, the improvement in the quality of observations at a wave length of 3.2 centimeters is so startling that wholly new re-

search vistas are offered by this development.

The scans reproduced here are of the strong radio source Cygnus A. One record was made in 1956 with the NRL 50-foot radiometer, the other with the same instrument in 1958 with the maser attached. The time constant in both cases was five seconds, but in 1956 the band-width was 11 megacycles, while with the maser it was five megacycles. The noise factor of nine decibels without the maser has been much reduced, the maser giving an improvement of about 16 times.

The Radio Background

New observational material on the general radio background of the sky was presented from Australia, Holland, and Great Britain.

Mills distinguishes four basic components in the background continuum of the southern sky within the 1-to-4-meter range:

1. A relatively minor, though cosmologically basic, extragalactic component accounting for about 30 per cent of the total radiation near the galactic poles.
2. A thin, all-enveloping galactic corona or halo.
3. A galactic disk component, concentrated strongly toward the central region of our galaxy.
4. A contribution from the flowing together of the extended discrete radio sources which merge gradually into the disk component.

Using a longer wave length, 15 meters, C. A. Shain at Sydney has completed a survey in which the band of the Milky Way appears as a trough of low intensity. This effect must be produced by the absorption of 15-meter radiation from great distances by ionized hydrogen in the central plane of the galaxy. One of the more prominent absorbers found in this survey is the nebulosity known as 30 Doradus in the Large Magellanic Cloud – it blocks out all radiation from beyond. Thus, Shain's techniques can be used to detect very large and distant regions of ionized hydrogen.

At a comparatively short wave length, 22 centimeters, G. Westerhout of Leiden has made a survey, which is being extended to the southern sky by C. M. Wade and J. V. Hindman at Sydney. The 22-cm. surveys deal partly with thermal radiation emitted by ionized gas clouds in our galaxy, and partly with a nonthermal component. This work has confirmed an earlier result of F. D. Drake at Harvard that the extended source Cygnus X is really a composite affair produced by possibly as many as 10 separate nebulae.

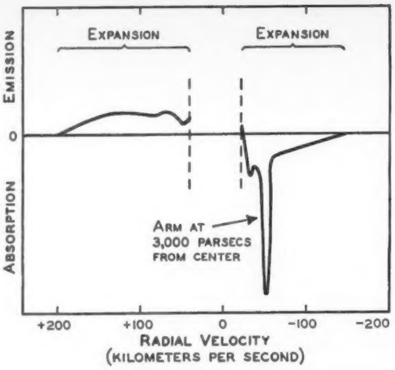
Much time was given to discussing the background irregularities observed at meter wave lengths. The Cambridge group has found evidence for the association of excess radiation with groups and clusters of galaxies.

21-Centimeter Research

The group of Dutch astronomers led by J. H. Oort and H. C. van de Hulst at Leiden continues to make important advances in research with the 21-cm. line of neutral hydrogen.

Van de Hulst and Louise Volders have studied the radiation received from several extragalactic systems, including the spirals Messier 33 and 101, both of which are of later type than our galaxy or the Great Nebula in Andromeda. They found that atomic hydrogen accounts for five per cent of the mass of M33 but only two per cent of M101; both values are, however, larger than the corresponding figures of 1.5 per cent and 0.9 per cent obtained earlier for ours and the Andromeda system, respectively.

Oort and G. W. Rougoor, studying the neutral hydrogen in the central part of the galaxy, find that the smaller component of the bright radio source Sagittarius A appears to be located directly at the center of our system (see page 617). The more extended component, originating in extensive clouds of neutral hydrogen surrounding the central core, reveals evidence of inner spiral structure. One arm is clearly marked at 3,000 parsecs from the center of the galaxy.

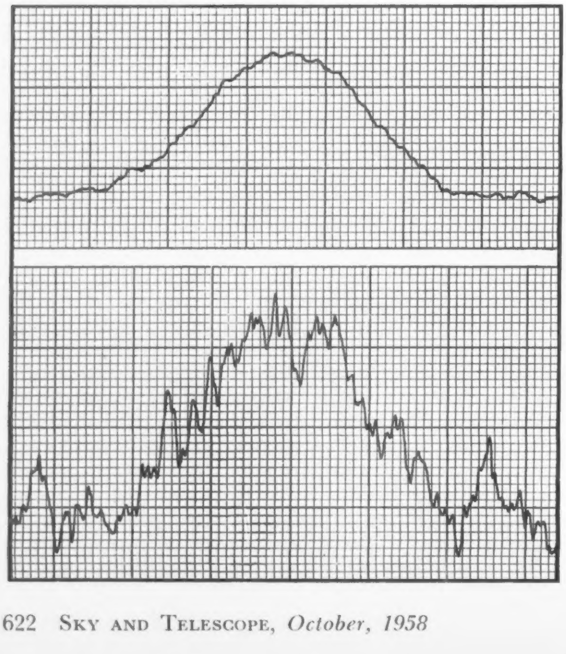


Evidence for an expansion of the neutral hydrogen gas in the central portion of our galaxy is provided by this chart of the profile of the 21-cm. line of hydrogen, as observed in the exact direction of the center. This diagram by J. H. Oort and G. W. Rougoor, of Leiden Observatory, is from observations with the 82-foot Dwingeloo radio telescope.

Of greatest importance, however, is the discovery that the neutral hydrogen gas in these inner clouds is expanding outward at rates varying from 50 to several hundred kilometers per second. For example, a profile of the 21-cm. line in the exact direction of the galactic center, taken with the 82-foot radio telescope at Dwingeloo, Holland, shows a conspicuous absorption dip at a wave length corresponding to a velocity of approach of 53 kilometers per second. The absorbing gas, which is about 3,000 parsecs from the galactic center, must be expanding at this speed, for there would be no line-of-sight component of its rotation around the nucleus of the galaxy.

If this and other observations indicate that the neutral hydrogen gas is generally expanding, a significant fraction of the mass of the galaxy would be involved during its lifetime, and the Leiden observations raise a number of serious questions. Where does the outward-moving gas originate? Is it neutral hydrogen expelled from the atmospheres of Population II stars in the nuclear region, and from precisely which stars does it come? Or is gas streaming into the nucleus from the galaxy's corona or halo, thereby renewing the supply? What role do magnetic fields play in producing the rapid expansion? The symposium considered these and related questions, but clear answers were not forthcoming.

Brief progress reports on the spiral



Two scans of the radio source Cygnus A show the great improvement when the maser is used (upper tracing). The maser is a low-noise amplifier that has a ruby for its working component. The Naval Research Laboratory's 50-foot antenna was employed for both observations, at a wave length of three centimeters.

structure of the Milky Way system from 21-cm. evidence were made. The Leiden results and those obtained in Australia by F. J. Kerr and his associates have been pieced together, and a generally coherent picture emerges. If averaged over the whole galaxy, neutral hydrogen is only about two per cent of the total mass, but the ratio increases from the center outward, reaching about 15 per cent in the neighborhood of the sun.

Absorption features in the 21-cm. spectra of several discrete sources have been studied by C. A. Muller of Leiden. He finds as many as five small clouds in Cassiopeia A, and eight in Cygnus A. At Jodrell Bank, R. D. Davies has evidence for very cool, small clouds of neutral hydrogen associated with dark nebulae.

A major contribution was contained in a report from the Department of Terrestrial Magnetism, Carnegie Institution of Washington. For the first time we are getting a clear picture of the distribution of neutral hydrogen at some distance both above and below the galactic plane.

The search for additional lines in the radio spectrum continues. R. L. Adgie of Malvern, England, reported negatively on a recent attempt to observe the deuterium line at a wave length of 92 centimeters. The sensitivity of his apparatus, a special receiver on the 250-foot radio telescope, was such that an upper limit of 1/4,000 can be given for the cosmic ratio of deuterium to hydrogen; on the earth, the corresponding abundance ratio is 1/5,000.

Theoretical Work

There is agreement on the general nature of the mechanism producing the strong radio radiation in nonthermal sources, such as supernova remnants. The vague suggestions about "plasma oscillations" have not born fruit. Instead, accumulating evidence now indicates that the primary mechanism is synchrotron radiation, as first suggested by I. S. Shklovsky of the U. S. S. R.

The lines of force in the large-scale interstellar magnetic fields must certainly follow spiral arms. Wherever there is an abundance of free electrons in the presence of a magnetic field, the electrons will spiral about the lines of force and radiate energy in so doing. This is the basic concept of the electron-accelerating machines known as synchrotrons.

Where there are free electrons, protons must also be present, and the latter are of special interest in studies of cosmic rays. The radio astronomer and the cosmic ray physicist may find much in common to discuss.

The only star radio astronomy deals with knowingly is the sun. E. Schatzman, University of Paris, suggested that it might pay to examine flare stars for possible radio emission. So accustomed have we become in galactic and extragalactic radio astronomy to think in terms of interstellar gas only, it is good to be reminded that there are still plenty of stars around us and that every one of them is a potential radio emitter.

ASTRONOMICAL SCRAPBOOK

The Selenographical Journal

HAVE YOU ever made a mental listing of some astronomy books that you would enjoy reading, if only they were written? One such book could be a history of amateur astronomy, its personalities, its organizations and their growth, and its major but unchronicled influence on "official" science. Another work still needed is a systematic history of lunar studies, giving a well-informed picture of the main currents in observation and interpretation, from Galileo's day to the present.

Both of these hoped-for books would contain some account of the old Selenographical Society. I first heard of this organization from a brief mention in the chapter about the moon in Thomas William Webb's classic manual, *Celestial Objects for Common Telescopes*: ". . . much is to be hoped from the researches of the Selenographical Society, established in London in 1878, which, comprising many eminent English and foreign astronomers, has for its object the collection and preservation of observations, and the indication of the most promising lines of research." But unfortunately, as a footnote in later editions states: "This Society was dissolved at the close of the year, 1882. . . ."

This organization was much more influential than its short life and present oblivion might suggest. There is a direct line of descent from it to today's flourishing British Astronomical Association and the Association of Lunar and Planetary Observers. Also, it published five volumes of the first magazine ever devoted exclusively to lunar matters.

The *Selenographical Journal* is extremely scarce today, at least in America. It is still well worth reading, both for the observations reported and for close-hand views of some interesting astronomical personalities.

The father of the society was an able and enthusiastic amateur, William Radcliff Birt (1804-1881), who, after making his name as a meteorologist, began about 1860 to devote himself to observing the moon. Under the auspices of the British Association for the Advancement of Science, he started the ambitious task of mapping the moon's surface in extreme detail, in co-operation with a band of amateurs that included Webb and W. R. Dawes of double star fame. But progress was slow, and after a few years the association withdrew its support.

Selenographical Journal.

No. 1. *APRIL 2nd*, 1878. *Vol. I.*

SELENOGRAPHICAL SOCIETY.

Officers and Council for the Year 1878.

W. R. Birt, Esq., *President.*

A. Anislie Common, Esq.	Edmund Neison, Esq. (*Editor*).
Nath. Green, Esq.	Rev. W. J. B. Richards (*Treasurer*).
George Knott, Esq.	Herbert Sadler, Esq. (*Secretary*).
Edmund G. Loder, Esq.	Rev. T. W. Webb.

THE object of this monthly bulletin is to secure the co-operation of the various students of the lunar surface. It is intended to contain, in addition to various *Ephemerides* giving such data as the position of the terminator, geocentric librations, &c., for days on which the Moon can be observed, certain diagrams of objects to which the attention of the members of the society will be from time to time directed, with instructions for the making of such observations as will be most valuable for the advancement of Lunar knowledge. Great advantages too are expected to be gained by the adoption of a standard nomenclature, and scale of brightness. The Editors will be glad to receive any queries or short notes connected with Lunar Topography.

W. R. BIRT, *President.*

THE OUTLINE DIAGRAMS.

These outline diagrams are intended to assist those observers who are drawing these regions, by putting at their disposal a carefully considered outline of the different regions. In this way they will find it easier to accurately draw these formations than if an outline has to be laid down at the telescope.

I.—FRACASTORIUS.

This formation is situated at the northern end of the Mare Nectaris, and appears to be the ruins of a large walled plain, in many respects

The circulation of the "Selenographical Journal" was probably never more than 200, and it is now extremely rare.

Birt then decided to form his own organization, and the Selenographical Society held its first meeting early in 1878. Volume I, Number 1, of its *Journal* was dated April 2nd of that year. The editor was Edmund Neison, who two years earlier, at the age of 25, had published a large and valuable lunar handbook.

The society had a flying start, with 60 members within a year. Among the active collaborators were such amateurs as Nathaniel Green, a fine artist whose drawings of Mars are still among the best, and A. A. Common, who was later to build and use a 60-inch reflector. The projects undertaken by this ambitious group included reform of lunar nomenclature, compilation of a complete list of books and pamphlets about the moon, and the resumption of work on Birt's large lunar map.

The pages of the *Selenographical Journal* show abundant observing activity. There are many articles and drawings inspired by the exciting news from Germany that on May 27, 1877, Hermann Klein had discovered a large crater in Mare Vaporum where he had seen none before. (This object, Hyginus N, is no longer believed to be an example of lunar change.)

Other articles deal with measuring crater co-ordinates with a simple micrometer, and an interesting note by Herbert Sadler tells of the successful use of an

(*Continued on page 628*)

OBSERVING THE SATELLITES

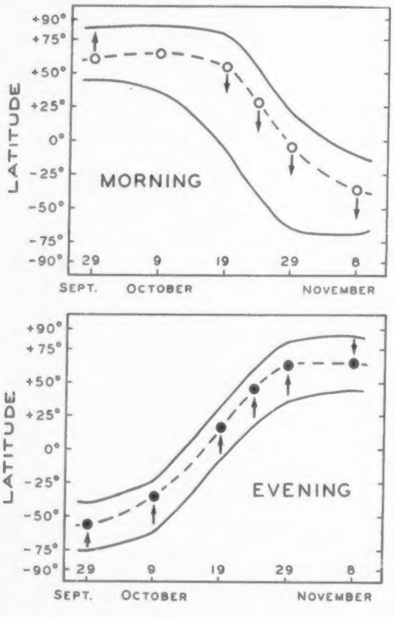
Space Age: Year One

OCTOBER 4TH marks the anniversary of the greatest technological achievement since atomic energy was unleashed. On that date last year the first artificial satellite was successfully placed in orbit.

The launchings of man-made moonlets by the Russians and Americans were tremendous engineering feats, but involved no major new theoretical advances. Ever since Newton's day, an artificial earth satellite moving in a stable orbit was theoretically conceivable, while early in our century H. Oberth's analyses and R. H. Goddard's experiments made it clear that multiple-stage rockets could be used to put such bodies aloft.

Even today, the general public scarcely realizes the intricate engineering problems that were mastered – the designing of high-speed fuel pumps for unstable liquids; the making of reaction chambers to work at extreme temperatures; the realization of elaborate systems to control the brief moments of guided flight with millisecond precision; meeting the severe limitations imposed on components by temperature and acceleration; and the all-important need to minimize the final assemblage's weight-to-thrust ratio.

As in few other undertakings, the launching of a satellite demands the successful co-ordination of hundreds of mechanical and electrical systems. Even when all the components perform well, an improbable chance can mean disaster – as on August 24th, when the first-stage Jupiter C of Explorer V separated properly, but later collided with the remaining stages of the package!



An extension of the long-range forecast of visibility zones of 1958δ1 from page 508, August issue. The arrows show northward or southward motion of the satellite at the latitudes where it passes into the earth's shadow (dark circles), or emerges from eclipse (open circles). Based on orbital elements for September 4, 1958.

There have been seven successful launchings during the first 11 months of the space age, putting 10 separate major objects into orbits. At the time of writing, six of these are still circling the earth, three of them with radios transmitting observations.

Looking back over the space age's first year, we can trace its deep impact on America, putting to one side considerations of international politics. The Sputniks gave a sharp spur to scientific education in the United States, leading Congress to pass on August 23rd the Science Aid Act, which provides 900 million dollars to help train scientists. New government agencies have been formed to deal with the novel urgencies of the space age. Soon after Sputnik I was launched, J. R. Killian was appointed science adviser to the President, and the Advanced Research Projects Agency was created within the Department of Defense.

More recently, the scope of the National Advisory Committee for Aeronautics was broadened to include a space program, and the NACA was renamed the National Aeronautics and Space Administration. In another development, the National Academy of Sciences and the National Research Council created a Science Space Board, for a joint survey of all aspects of man's advance into space.

Satellite research is of course a part of the International Geophysical Year, which was scheduled to end in December, 1958. However, in August the IGY governing committee decided at Moscow that the co-operative programs be continued wherever possible. This limited extension will be known as the International Geophysical Co-operation – 1959.

Full analysis of the enormous wealth of satellite data already acquired will take many months, but the initial results are exciting. The upper atmosphere turns out to be appreciably denser than we had thought, and temperature measurements in those regions now replace uncertain estimates. Satellite observations are allowing a redetermination of the oblateness of the earth, and of the distribution of mass inside it; eventually they will tie together the geodetic networks covering Europe and the United States more accurately than ever before.

Counts of micrometeorites in the neighborhood of the earth have been announced. Other programs measure the intensity of solar radiation, and the magnetic and electrical properties of the earth's surroundings. Biological studies have begun, with indications that future space voyagers can re-enter the earth's atmosphere without undergoing lethal temperatures. But a new hazard to space travel is the unexpectedly high intensity of cosmic radiation, which doubles for each 60 miles of altitude above 250 miles.

As the first year of the space age ends, we can foresee some other advances in the near future. One possibility is an artificial satellite that will release an inflated balloon perhaps 12 feet in diameter; because of its sensitivity to air resistance, it should allow excellent determinations of upper atmosphere densities. A telescope mounted on a satellite platform is being planned, and the first successful rocket to the moon may soon be history.

Lunar Probes

NOW that a stable orbit around the earth has been attained repeatedly, the next step toward space travel is to achieve escape velocity. This is an essential part of the plan for the lunar

The rocket of Sputnik III flashes as it nears bright Vega, in Lyra, and suddenly disappears in the earth's shadow. Photograph by Ken Thomson, Pasadena, Texas, at 3:56 UT, August 18, 1958.

probe vehicles to circle the moon; the first United States attempt failed on August 17th.

To the public, the most exciting part of a successful lunar probe may be "seeing" the unknown far side of the moon. For this purpose, the August 17th vehicle had an electronic scanning device sensitive to infrared radiation. But there were equally important experiments for counting meteoric particles in space and for measuring temperature and magnetic fields. Five tracking stations have been set up, at Patrick Air Force Base, Florida; San Diego, California; Hilo, Hawaii; Singapore, British Malaya; and Manchester, England, for tracking the probes in flight toward the moon and for receiving their telemetered signals.

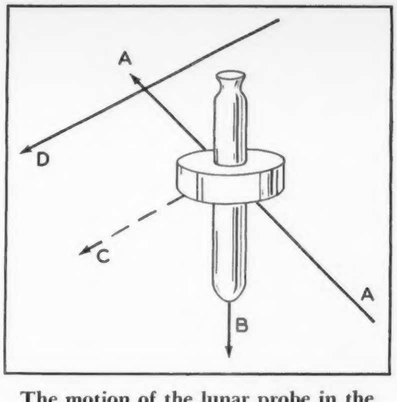
The United States Air Force has been authorized to attempt three moon shots and the Army two. The Air Force rocket complex has a Thor IRBM for the first-stage booster, and a modified Able rocket for the second stage, both with liquid-fuel motors. The solid-propellant third stage has been newly developed by the Navy's Allegheny Ballistics Laboratory. These three stages are designed to provide enough speed to bring the probe within the moon's vicinity about 62 hours after launching.

After the third-stage rocket burns out, the lunar probe will be moving at a velocity greater than that of escape from the earth, 25,500 miles per hour. Its orbit with reference to the earth will be hyperbolic, and it would go right by the moon if a final-stage retro-rocket were not fired (by command signal from Hawaii). Its purpose is to slow down the probe and allow capture by the moon's gravitational field.

If a rocket were fired at a lower velocity, so that its orbit with reference to the earth would be a very large ellipse, it would require about five days to reach the moon, instead of the $2\frac{1}{2}$ days planned by the Air Force using a hyperbolic orbit.

Each launching from Cape Canaveral awaits a favorable position of the moon. The eastward rotation of the earth imparts a tangential velocity, about 910 miles per hour at that latitude. Thus the most favorable condition for launching requires that the intersection of the trajectory with the moon's orbit lie in a specific direction at firing time — a condition attained only once a day. Furthermore, to improve the probability of interception, the plane of the trajectory should be inclined as little as possible to the moon's orbital plane. This condition occurs only at a specific time during the lunar month. The accompanying diagram shows that from the latitude of Cape Canaveral the minimum angle between the two planes during October is about 10 degrees. Conditions are favorable at about 9:00 UT on the 11th.

The optimum trajectory for placing the probe into a circumlunar orbit is by no

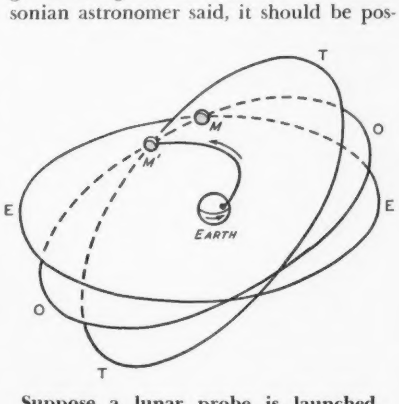


The motion of the lunar probe in the direction A will be modified by the thrust of a retro-rocket toward B, producing a resultant motion C. If all goes well, vector C will be approximately parallel to D, the direction of the moon in its orbit, and will be near enough to the moon to permit the probe's capture.

means easy to calculate. There is no exact analytical solution, owing to the complications introduced by the ever-changing weight-to-thrust ratio as the rockets are firing, and by the varying gravitational attractions of the earth, moon, and sun. Modern high-speed computing machines are needed to select a trajectory that offers a reasonable chance of success, and after the orbit has been chosen the control system must operate with extreme precision.

A Telescope in Space

A MAJOR BREAKTHROUGH in astronomical observing methods is already technically possible, Fred L. Whipple told the International Astronautical Federation at its Amsterdam meeting in August. In 18 to 24 months after a go-ahead signal, the Harvard and Smithsonian astronomer said, it should be possible to place an astronomical telescope in a satellite orbit.



Suppose a lunar probe is launched from Cape Canaveral when the moon, M, is crossing the celestial equator, EE, from north to south. The probe's trajectory will lie in plane TT, inclined $28\frac{1}{2}$ degrees (Cape Canaveral's latitude) to EE, and will intersect the moon's orbit plane, OO, when the moon has reached M'. In October, OO is inclined about $18\frac{1}{2}$ degrees to EE.

The terrestrial atmosphere is opaque to short-wave optical radiations of great astrophysical importance. This limitation was discussed in W. A. Rense's article on page 502 of the August *Sky and Telescope,* and by Otto Struve on page 445 in July. The greatest value of a telescope mounted on a satellite platform would be for systematic observations in the far-ultraviolet and X-ray regions of the spectrum. A second potential advantage would be increased image sharpness, because the space telescope's performance would be unaffected by atmospheric turbulence. Dr. Whipple tentatively recommends that the orbiting telescope form its images on the sensitive surface of a television transmitting tube.

The power supply must not only operate the scanning device and its transmitter, but must aim and focus the telescope, and stabilize the platform. For the last, it is not enough to separate the platform from its mother rocket with zero rotational momentum; there must also be provision for continuously correcting any spin that may develop. The Russians have reported complete stabilization from spin for their nose cone that carried two dogs to 281 miles and returned them alive to earth on August 27th.

Basically, there are two methods for counteracting spin. In one, angular momentum is transferred from the entire object to a part of it, for example the battery case. In the other, a fluid is propelled at high speed in the proper direction to achieve the desired stability.

Even when the space telescope is outside the earth's shadow, bathed in direct sunlight, it will view a dark sky because it is above the atmosphere. Consequently, it should be able to survey the entire heavens quickly, except for the region nearly in line with the sun. The speed of such a survey will depend mainly on the exposure time required by the scanning device. Dr. Whipple and his co-workers point out that with a field of four square degrees about 10,000 direct images would cover the whole sky — almost the number of images transmitted by commercial television in six minutes.

"As a tentative initial thought, an 8-inch-aperture off-axis mirror of focal length 24 inches, with a nearly conventional TV recording surface, would give a resolving power of the order of 20 seconds. . . ." Dr. Whipple's proposal also envisages the use of an objective grating, or other dispersive device, so that a survey of ultraviolet stellar spectra could be carried out. If this program can be put into effect, a very rich harvest of astrophysical information should result.

MARSHALL MELIN
Research Station for Satellite Observation
Harvard Observatory
Cambridge 38, Mass.

NEWS NOTES

RADIO TELESCOPE AT SUGAR GROVE

The United States Navy has announced its intention of building a $79,000,000 radio research facility near Sugar Grove, West Virginia. The 400-acre site is about 30 miles northeast of the National Radio Astronomy Observatory at Green Bank, where an 85-foot telescope is to be in operation this winter (see July, 1956, issue, page 398).

The two installations are separate and have quite different purposes, basic research in radio astronomy at Green Bank (under the National Science Foundation) and applied research on defense problems at Sugar Grove. Considerable confusion was caused by a press release in June which suggested that the Sugar Grove facility was primarily for astronomical research. This misconception was corrected in the July hearings before a House of Representatives subcommittee on appropriations.

At these hearings, a Navy spokesman stated that information valuable to radio astronomy would result as a by-product of the new station's program. The installation is to include a 60-foot pilot antenna, to be followed by an instrument whose collecting area will be considerably greater than the 250-foot paraboloid at Jodrell Bank in England. The spokesman mentioned the possibility that the large instrument might be used in the reflection of radio signals from the moon for communication purposes.

RED STARS NEAR THE GALACTIC NUCLEUS

Some eight years ago, objective-prism plates taken at the Warner and Swasey Observatory indicated that a very large number of red stars (spectral type *M*) can be observed in the direction of the galactic center. J. J. Nassau and V. M. Blanco have now extended their earlier work, using spectrum photographs taken at Tonanzintla Observatory in Mexico.

They report, in the July, 1958, *Astrophysical Journal,* their search for giant *M*-type stars near the globular cluster NGC 6522, which lies in a region only lightly obscured by interstellar matter, yet nearly in the direction of the galactic center. This search probably reached the nucleus of the galaxy and extended beyond it. In an area of 390 square minutes of arc, within 11.2 minutes of the cluster but not including it, 210 *M*-type stars were found.

When these are listed by magnitude intervals, most of them lie between photographic magnitudes 15.5 and 19.0, with the maximum number of stars at 17.5. Drs. Nassau and Blanco believe this maximum is due to the high space density of *M*-type giants in the galactic nucleus. Therefore, when the absolute magnitudes of these stars and the amount of interstellar absorption become known with sufficient accuracy, the distance to the galactic center can be derived from this study.

This same region surrounding NGC 6522 had been very carefully searched for faint variable stars by W. Baade at Mount Wilson and Palomar Observatories. When his results are compared with the spectroscopic survey, it turns out that the proportion of very late *M* stars that are variable is much less than in other parts of the Milky Way.

MAGELLANIC CLOUD VISUAL BRIGHTNESSES

One of the most difficult problems in photometry is to determine the brightness of an area in comparison to a point source. Usually in such comparisons an attempt is made to reduce the apparent size of the area to a point. Sergei Gaposchkin, Harvard Observatory, has reversed this procedure in a redetermination of the visual magnitudes of the Large and Small Magellanic Clouds.

Both clouds lend themselves to this approach. The Small Cloud is more or less uniform in brightness, while the large one may be divided into two or three zones of approximately equal brightness. Dr. Gaposchkin compared extrafocal images of nearby stars of known magnitudes with corresponding areas of the Large Cloud, observing through binoculars of such low power that the naked-eye appearance of the object was preserved.

His observations, made at the Mount Stromlo Observatory on several nights, show the visual magnitude of the Large Magellanic Cloud to be -1.26, slightly brighter than that of -1.0 derived by G. de Vaucouleurs and considerably brighter than photoelectric results.

Previously, the Harvard astronomer had estimated the difference in magnitude between the two clouds to be 2.49. Thus, the visual magnitude of the Small Magellanic Cloud is $+1.23$. If the distance modulus is assumed to be 19.00 magnitudes, the visual absolute magnitudes are -20.26 and -17.77 for the Large and Small Clouds, respectively.

This work is reported in the March issue of the *Irish Astronomical Journal.*

SAMUEL G. BARTON DIES

One of America's most active double star observers, Samuel G. Barton, passed away on June 3rd at the age of 76, in Philadelphia, Pennsylvania. He was a staff member of the University of Pennsylvania's Flower Observatory from 1914 until his retirement in 1951.

Dr. Barton discovered over 3,000 new double stars by searching the Carte du Ciel catalogues, and he made many micrometer measurements of doubles with the Flower 18-inch refractor. His work also covered the history of astronomy, star positions, and orbits of comets and asteroids. He was co-author with W. H. Barton, Jr., of *Guide to the Constellations.*

IN THE CURRENT JOURNALS

FORMATION OF ELEMENTS IN THE STARS, by Margaret and Geoffrey Burbidge, *Science,* August 22, 1958. "Astrophysical observations and experiments in nuclear physics in the last decade have lent increasing support to the idea that all of the elements have been built from hydrogen in stars."

A QUANTITATIVE ANALYSIS OF THE RONCHI TEST IN TERMS OF RAY OPTICS, by A. A. Sherwood, *Journal* of the British Astronomical Association, July, 1958. "This paper deals with the relation between the Ronchi shadow bands and the figure of the mirror. The formulae derived enable the shape of the shadow bands to be calculated for a concave mirror of near spherical figure of shallow or deep curvature, and also for an aspherical figure of shallow curvature, provided that it is a surface of revolution. The converse problem, that of finding the figure of the mirror from the shape of the shadow bands, has been solved by an approximate method of deviation from a given reference surface (i.e. a sphere)."

PLEIADES PHOTOMETRY

At Lowell Observatory, H. L. Johnson and R. I. Mitchell have measured the magnitudes and colors of virtually every star known to belong to the Pleiades cluster. From their photographic observations with the 13-inch refractor, and from photoelectric measures with the 21- and 42-inch reflectors, they conclude that there are 262 Pleiades members brighter than visual magnitude 16, as well as 27 probable members.

Their color-magnitude diagram for the Pleiades stars shows an interesting feature – the main sequence becomes very broad for stars fainter than magnitude 12. The Lowell astronomers suggest this scatter is connected with the likelihood that many of the fainter stars are still in the stage of gravitational contraction.

In addition, discordances in the measured magnitudes of these faint red stars indicate that many of them are variable. One of them showed a three-magnitude increase in brightness which subsided within an hour; five other stars are also suspected of flaring. These facts support the conjecture, made by the Lowell astronomers in the July *Astrophysical Journal,* that flare stars are objects in the process of gravitational contraction.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 100th meeting of the American Astronomical Society at Madison, Wisconsin, in June, 1958. Complete abstracts will appear in the Astronomical Journal.

Apsidal Motion in HR 8800

The only observational evidence about the distribution of the matter within a star — its density gradient — comes from the rate of rotation of the line of apsides in certain spectroscopic and eclipsing binary systems. The line of apsides joins the periastron and apastron points of the binary star's orbit.

One of the best observed cases of this effect in a spectroscopic binary was reported by R. M. Petrie, Dominion Astrophysical Observatory. Orbital elements for the star HR 8800, of spectral type *B3*, were determined by R. K. Young in 1919. The eccentricity was 0.23, the period 3.337 days, and the periastron angle about 126 degrees. New observations with the 73-inch reflector were made in 1957, and show the periastron angle to be 210 degrees, indicating a period of 165 years for the apsidal motion.

HR 8800 is a 6.6-magnitude star in Andromeda, with the 1950 co-ordinates $23^h\ 05^m.0$, $+45°\ 48'$.

Lifetimes of Solar Pores

A study of pores, the minute dark spots that appear on high-resolution photographs of the sun, by J. D. R. Bahng, Princeton University Observatory, shows that they are extremely stable. He used some of the films taken by Project Stratoscope with apparatus carried 80,000 feet into the stratosphere (*Sky and Telescope,* January, 1958, page 112).

In one series of time-sequence photographs lasting for 47 minutes, a group of pores showed no appreciable change in appearance, while the lifetimes of photospheric granules in the same series was of the order of five minutes. Thus, the pores seem to have no direct connection with the sun's granular structure. This conclusion supports the suggestion by G. Abetti in 1929 that pores are extremely small sunspots.

Star Cluster Lifetimes

During its evolution a cluster of stars is subjected simultaneously to a number of disruptive processes. The effects of two dominant ones have been investigated by Ivan King, University of Illinois Observatory.

The first process is the loss of individual stars because some of them attain sufficient velocity to escape. This ejection takes energy from the cluster and causes it to contract, which in turn increases the ejection rate. Thus, the assemblage tends to lose stars faster and faster, and the process is most effective for dense clusters.

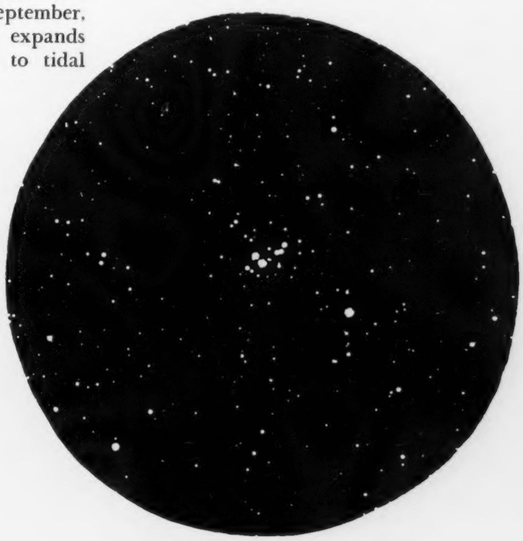
For a loose one, on the other hand, the dominant effect comes from encounters with clouds of interstellar material. Lyman Spitzer, Jr., Princeton University astronomer, has shown that each passing cloud exerts a tidal force, the effect on the individual stars tending to increase the energy of the cluster as a whole (*Sky and Telescope,* September, 1958, page 555). The cluster expands and becomes more susceptible to tidal forces, and soon tends to be disrupted entirely.

Dr. King has studied the simultaneous effect of these two processes, finding a limiting case where they balance each other. If the radius of a cluster is the critical value predicted by the exact theory for a given number of stars, it will have a maximum theoretical lifetime. For example, a cluster with a radius of little more than one parsec, containing 100 stars, has a maximum life expectancy of 6×10^9 years.

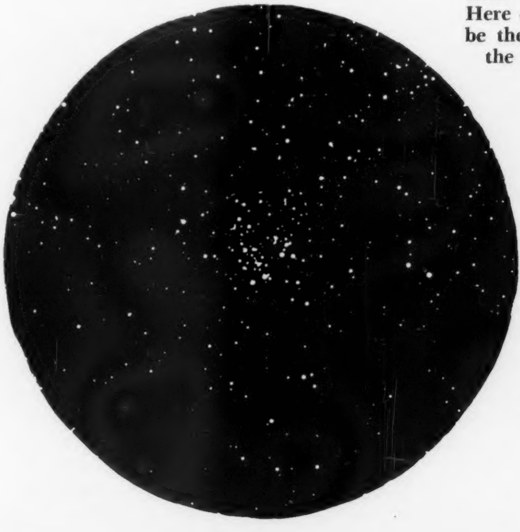
However, the balance between the expanding and contracting influences is so unstable that a cluster that does not have the precise critical radius cannot attain the *theoretical* maximum lifetime. If, in the previous example, the radius is changed by only 1/5,000, it will shorten the lifetime to 3×10^9 years. Therefore, Dr. King speaks of a *practical* maximum life for this 100-star cluster of just 10^9 (one billion) years. And even for 1,000 stars in the same volume, the maximum expected lifetime is only 5×10^9 years.

Thus, the exact theory makes a difference only near the critical radius which, in practice, may be used to divide the expanding clusters, subject to tidal forces, from the contracting ones, subject to ejection losses. It is rarely necessary to consider the simultaneous operation of cloud encounters and the ejection of stars — one or the other nearly dominates completely. In either case, in the sun's part of the Milky Way a galactic cluster should last about a billion years.

Dr. King pointed out that these objects are therefore a temporary part of the celestial scenery. Furthermore, as clus-



Right: The open cluster NGC 7160 in Cepheus is highly concentrated toward the center, and according to R. J. Trumpler contains less than 50 stars. Here ejection of stars may be the dominant effect in the cluster's evolution.



Left: The open cluster NGC 663 in Cassiopeia is an extremely loose grouping of from 50 to 100 stars, probably tending to lose stars by encounters with interstellar clouds. From Markaryan's atlas of galactic star clusters.

ters near the critical radius change more slowly, we are more likely to observe them. This means that whatever the distribution of radii is at the time of their formation, the distribution observed at any moment is strongly biased in favor of the critical value.

In presenting his simplified approach to the problem, the Illinois astronomer cautioned against too literal use of his results. The numerical values are subject to further change; clusters not in the plane of the galaxy are less affected by cloud encounters and have longer lifetimes; rich, dense ones are not affected so much by cloud encounters, while the poorest clusters have their lives shortened by the tidal force of the nucleus of the galaxy.

Metal Abundances in K-type Stars of Population II

In order to explain the differences between stars of Population I and Population II, more information is needed concerning the relative abundances of elements in their atmospheres. This work requires careful analyses of detailed observations of the intensities of lines in their spectra.

To study these differences in stars of late spectral type, where the lines of metals are strong, H. L. Helfer and G. Wallerstein, Mount Wilson and Palomar Observatories, selected three stars of Population II: one each in the globular clusters M13 and M92, and one extremely high-velocity star (HDE 232078). For comparison purposes they included a fourth sample star in the galactic cluster M41, which is of Population I. They carried out curve-of-growth analyses from spectrograms with a dispersion of 18 angstroms per millimeter.

Although all four stars are giants of spectral type *K*, the first three have extremely weak metal lines, indicating a metal abundance only 1/100 that in the sun. The fourth star, of Population I, yielded roughly the solar abundance of metals.

Solar "Points"

In hydrogen and calcium spectroheliograms, or by means of Lyot Hα filters, small bright "points" can be observed on the sun, generally on the outer edges of the penumbrae of sunspots. They are usually circular and of very small size, less than a second of arc. They are numerous, three or four per spot, with average lifetimes of about nine minutes, though some last only two minutes, and are recurrent.

In describing this phenomenon, Orren C. Mohler and Helen W. Dodson, McMath-Hulbert Observatory, pointed out that it is the same as the "hydrogen bombs" of F. Ellerman in 1917 and the "moustaches" of A. B. Severny in 1955. These objects were observed through filters by B. Lyot in 1944, and his name "points" has been adopted because of their appearance.

Points have a characteristic spectrum: brilliant emission streaks extending several angstroms on either or both sides of the Hα line but not crossing it. The emission on the violet side is generally more intense than that on the red.

At the McMath-Hulbert Observatory, points are observed by two methods. They are seen visually in a Lyot Hα filter and then placed on the slit of the vacuum spectrograph for definitive identification and study. Also, they are recorded on series of 15 spectroheliograms made at different wave lengths, spaced systematically within three angstroms on either side of the center of the Hα line or the K line of calcium.

The general association of points with inactive as well as active spots indicates that they should be considered part of the normal development of a sunspot.

Mass of a Long-Period Variable in Ophiuchus

One of the most fundamental relationships in astronomy is the stellar mass-luminosity law, based on studies of binary stars. Often this relation is used to estimate the mass of a star whose intrinsic brightness is known. But this procedure breaks down badly for long-period variable stars, it has been found by J. D. Fernie of Indiana University's Goethe Link Observatory.

X Ophiuchi is a visual binary system, consisting of a long-period variable, changing between magnitudes 6 and 9 in a 337-day period, and a normal *K*2 giant. There are only two other known cases of long-period variables having close companions (Mira and R Aquarii).

Dr. Fernie computed the masses of the two components from the observations since 1900, which define only about a 50-degree arc of the apparent orbit; he also used radial velocity observations. The mass of the variable star was found to be 0.8 solar mass, consistent with A. J. Deutsch's work on Mira. The *K* giant turned out to be 1.2 times as massive as the sun.

Neither figure can be considered accurate, as the orbit of X Ophiuchi is almost indeterminate. Nevertheless, Dr. Fernie could conclude that the mass of the variable is definitely greater than 0.4 sun and probably less than two suns. The value of 13 solar masses previously supposed on the basis of the mass-luminosity law is undoubtedly too high.

BOUND VOLUMES OF ASP "LEAFLETS"

Volumes IV, V, and VI of the *Leaflets* of the Astronomical Society of the Pacific have been reprinted and bound in cloth. Each volume, which contains 50 numbers, is $3.00 postpaid, and may be ordered from the society, 675 18th Ave., San Francisco 21, Calif.

ASTRONOMICAL SCRAPBOOK

(Continued from page 623)

unsilvered 15½-inch mirror for viewing detail near full moon. Noteworthy are the long series of excerpts from the observing books of J. F. J. Schmidt, and also of Heinrich Schwabe, who besides discovering the 11-year sunspot cycle was an active selenographer.

Photography was beginning to come into its own astronomically. Common in 1879 wrote detailed instructions for taking "photograms" of the moon, and commented on the great convenience of the newly invented gelatin dry plate, compared to the older collodion process.

Going through the *Selenographical Journal* from month to month, we see for a time energetic growth of the society. This prosperity ended abruptly with the sudden death of Birt on December 14, 1881. As president of the organization from the beginning, he had been its driving force.

The reports of the society's council meetings show that the disintegration was rapid. Within a few months finances were causing alarm; arrears in dues left no way of meeting a printer's bill of £40.

More serious still was the breakdown in co-operative observing, which caused a shortage of contributions to the *Journal*. Although the membership list contained many famous astronomical names (David Gill and R. T. A. Innes, for example), a growing proportion was of persons not active in lunar work. Finally, Neison left for South Africa on an expedition to observe the 1882 transit of Venus, and the *Selenographical Journal* suspended publication with No. 59, dated December 10, 1882.

JOSEPH ASHBROOK

ARATOS' "PHAENOMENA" TRANSLATED FROM THE GREEK

One of the oldest classical descriptions of the constellations, *Phaenomena* or celestial "Appearances," was written by the Greek poet Aratos about 270 B.C. The poem became famous in its time, and for hundreds of years had wide influence, being translated into Latin by Cicero and others.

The verses have been translated into English directly from the Greek by William I. Barnholth. His version is more readable than some other translations, yet adheres faithfully to the original text. Nonastronomical digressions and the part on weather signs have been omitted to give the poem greater unity and continuity, yet the astronomical portions are complete.

Mr. Barnholth has prepared mimeographed copies of his translation, with explanatory notes. These may be obtained from him for 50 cents each to cover printing and mailing costs. His address is 2060 17th St., S. W., Akron 14, Ohio.

CONVENTION IN PASADENA

ALAN McCLURE

Los Angeles Astronomical Society

On a sunny day in May this year, the observing cupolas were open on the Mount Wilson solar tower telescopes. The 60-foot is at the right, the 150-foot at the left.

MORE THAN 200 people registered for the 10th annual convention of the Western Amateur Astronomers, which was held at California Institute of Technology in Pasadena, August 15-17. The sponsors were the Pasadena Association of Amateur Astronomers, the Los Angeles Astronomical Society, the Whittier Amateur Astronomers Association, and the Excelsior Telescope Club of Long Beach.

The day before, there was a separate gathering of the Association of Lunar and Planetary Observers, which drew 73 registrants. Dinsmore Alter, recently retired director of the Griffith Observatory, spoke about the surface of the moon. Various ALPO members gave reports on lunar and planetary observations.

Even before the actual presentation of papers, delegates from the 20 member societies were able to learn of their content from the 127-page mimeographed *Proceedings,* edited by E. E. Sloman of Pasadena. Available at the time of registration, this book contained the papers of eight speakers and the convention's two symposia, one on telescope making, the other on variable stars.

Eugene C. Larr, Pasadena, and Mr. Sloman were in charge of setting up the program. There was an exhibit, with a large number of fine drawings, photographs, and paintings, along with telescopes made by both amateurs and professionals.

Opening the convention, Dr. Paul W. Merrill, Mount Wilson and Palomar Observatories, stressed the value to professional astronomers of the observations of variable stars by amateurs. He recommended the use of photoelectric photometers to measure star brightnesses with greater accuracy. He also suggested that any telescope fitted for photography could be used to advantage in recording stellar spectra by means of a 10- or 15-degree objective prism.

By popular demand, the time-lapse color motion pictures of Jupiter and Saturn, by Dr. Robert Leighton of Caltech, were shown twice.

An unexpected rainstorm marred the field trip to the 60- and 150-foot tower telescopes at Mount Wilson Observatory on Friday afternoon, August 15th. However, a number of instruments were inspected, and Dr. Seth B. Nicholson gave a talk on the solar cycle.

That evening the Morrison lecture was given by Dr. Gerard de Vaucouleurs, Harvard Observatory, on the local supercluster of galaxies. He believes superclustering to be a general characteristic of the distribution of galaxies, and that some of the huge superclusters are rotating. He concluded his talk with numerous suggestions for amateur work with instruments of moderate size. Stellar photometry was suggested for apertures larger than 15 inches and a photographic patrol program for smaller astrographic cameras.

At the symposium on telescope design and engineering that same evening, Thomas R. Cave, Jr., Long Beach, pointed out that conventional reflectors and refractors are capable of very fine optical performance if they are properly built. He believes it best for amateurs to master these standard forms before tackling the much more complicated catadioptric systems.

George Carroll, Tujunga, stressed that a good small telescope is better than a poor large one. In designing a telescope one should bear in mind the purpose for which it is intended. Then decide what type of mounting is best and whether a clock drive and circles should be used. It is usually difficult to add a drive or setting circles to a mounting if these

Eight of the leading delegates to the convention are seen in this photograph by the author. From left to right: Thomas R. Cave, Jr., Cave Optical Co.; Chalmers B. Myers, Excelsior Telescope Club; Arthur S. Leonard, Sacramento MOONWATCH team leader; Dr. Paul W. Merrill, Mount Wilson and Palomar Observatories (retired); George Perkins, WAA convention chairman; Thomas A. Cragg, Mount Wilson and Palomar Observatories; Walter H. Haas, Association of Lunar and Planetary Observers; and Alika K. Herring, Cave Optical Co. The sessions were held at California Institute of Technology.

The 10th annual convention of Western Amateur Astronomers, Pasadena, California, August 15-17, 1958. Photo by Allen Hawkins.

have not been planned for in advance.

High-vacuum coatings for telescope mirrors and objectives were the subject of James Dougherty, Los Angeles. He compared the coating on a mirror to the finish of a new automobile — both will last for years if properly treated.

The final talk was by Carl E. Wells, Roseville, who tackled the problem of a power supply for portable telescope clock drives. He made three suggestions: buy an electric shaver inverter to plug into a car cigarette lighter; build an inexpensive vibrator inverter; or build one of the new transistor inverters. Diagrams were shown for the construction of the last two, both run from dry cells, and are printed in the *Proceedings*.

Four papers were presented Saturday morning. Dr. A. R. Hibbs of the Caltech Jet Propulsion Laboratory spoke on satellite programs; E. O. Lorenz, Long Beach, discussed sunspot observations and told how the amateur can determine his own *k* constant (the factor that converts an observer's count to a standard system); C. P. Custer, Stockton, described the techniques of astronomical photography; and R. T. Jones of Palo Alto made suggestions concerning equipment for high-altitude telescope observations.

Highlights of the Saturday afternoon program included a discussion of conditions on Mars and Venus by Dr. Robert S. Richardson, Griffith Observatory, and a report about the Palomar 48-inch Schmidt sky survey, by Dr. George O. Abell. He noted that 87 new planetary nebulae, 13 comets, and 13 globular clusters are among the objects discovered during the survey.

The next speaker, Walter H. Haas, Las Cruces, New Mexico, discussed central-meridian transits of Jupiter, a valuable but sorely neglected part of amateur planetary studies.

The final part of the afternoon program was given over to a variable star symposium. Claude B. Carpenter, Romoland, gave a brief history of the American Association of Variable Star Observers. He was followed by Thomas A. Cragg of Mount Wilson Observatory, who spoke on the regular red variables. The final paper, a discussion of the classes of irregular variables, was by Lief J. Robinson of Sylmar.

In the evening Dr. Alter received the G. Bruce Blair award for his astronomical contributions, especially to amateur astronomy; the topic of his address was "Recollections of an Astronomer." Later, over 20 telescopes, ranging from 12½ inches downward, were assembled for a star party in Altadena.

The final session included a talk by Gary L. Steelman of Glendale about the Zeiss planetarium, and three papers on artificial satellites. Lewis C. Epstein, San Francisco, discussed orbits and precession, while Walter C. Marion of Oakland and Walter A. Munn of the Smithsonian Astrophysical Observatory commented on MOONWATCH and artificial satellite observations, respectively.

At the final business meeting, Mr. Larr invited the delegates to visit his optical shop to see the 30-inch mirror that he is grinding for the Pasadena society. Walter J. Krumm was elected to succeed George Perkins as chairman, and it was announced that next year's meeting will be held in Denver, Colorado, as part of the nationwide amateur astronomers convention, August 28-31.

Conventioners inspect the telescopes in the exhibit room. Robert T. Jones, who is standing at the far right in front of the picture of Mars, explains his reflector-corrector to a group of telescope makers. Photograph by the author.

MIRROR MAKING CLASSES IN NEW YORK CITY

Two separate classes in mirror making, limited to 15 students in each, are to be held weekly at the American Museum-Hayden Planetarium in New York City. The first meetings will be on Tuesday, September 30th, and Thursday, October 2nd, from 7 to 9:45 p.m.

Each student will make a 6-inch telescope mirror, for which no previous technical knowledge is needed. The course is sponsored jointly by the museum and the Optical Division of the Amateur Astronomers Association. Further information may be obtained by telephoning TR 3-1300, extension 509.

Amateur Astronomers

TELESCOPE MAKERS MEET AT STELLAFANE

VERMONT SKIES cleared only intermittently during the nighttime observing on August 16-17, when 300 persons attended the telescope makers' convention at Springfield. As in former years, the guest of honor was Governor Joseph B. Johnson, a member of the Springfield Telescope Makers, who were joint hosts with the Amateur Telescope Makers of Boston.

During the afternoon discussion meeting, Stanley Brower, Plainfield, New Jersey, presented an exhibit of various kinds of eyepieces and their components; he outlined the best procedures for eyepiece manufacture and urged amateurs to make their own oculars.

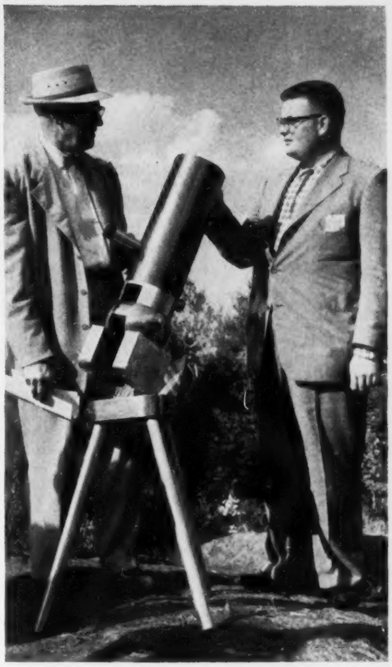
Michael Glowa, Springfield, Vermont, described the many ways in which optics are used for fabrication and testing in present-day industry. Paul Valleli, Dorchester, Massachusetts, recounted his method of cutting worm gears on a lathe and presented several examples of his work.

Later, a special meeting of the "Maksutov club" was held by Allan Mackintosh, Glen Cove, New York. There is considerable enthusiasm for this program, which Mr. Mackintosh is conducting.

At the evening session, special tribute was paid to the memory of two famous members of the Stellafane group: John M. Pierce, Springfield, and Albert G. Ingalls, Cranford, New Jersey, both of whom contributed significantly to the telescope making movement. The principal speaker was Frank Cooke, a professional optician of North Brookfield, Massachusetts, whose title was "Polygons, Diamonds, and the Baker-Nunn Camera." He showed color movies of the fabrication of aspheric optical surfaces by diamond generating wheels, and the shaping of optical elements by specially designed machines.

The evening clouds prevented the testing of telescope performance, but in the afternoon the four dozen instruments displayed were examined for mechanical excellence. First place was awarded to David W. Cogswell, West Springfield, Massachusetts, for the ball-type mounting of a 6-inch Maksutov reflector. A. Dounce, Rochester, New York, won second place with a 7½-inch f/7.5 equatorially mounted quartz reflector, and third prize was awarded to Albert H. Nagler, New York City, for an 8-inch reflector with a wooden tube (pictured in *Sky and Telescope*, October, 1957, page 590).

In attendance at this convention were telescope makers from such distant states as California, Georgia, Illinois, Louisiana, Nebraska, and Virginia.



One of the Stellafane judges, John E. Lovely (at left), and David W. Cogswell with his prize-winning telescope.

AAVSO FALL MEETING

The annual fall meeting of the American Association of Variable Star Observers will be held on Friday and Saturday, October 10-11, at the Springfield Museum of Natural History, Springfield, Massachusetts. On Friday at 8 p.m. Margaret and Newton Mayall will describe their recent trip to the International Astronomical Union general assembly in Moscow, as well as visits to AAVSO members in Scandinavia. Additional information may be secured from the AAVSO, 4 Brattle St., Cambridge 38, Mass.

A portion of the crowd at the afternoon session of the Stellafane meeting. Summer haze almost hides Mt. Ascutney in the distance, seen just over the top of the famous turret telescope. Photographs by Robert E. Cox.

WILMINGTON, DELAWARE

The Delaware Astronomical Society, organized by a small group of amateurs in Newark two years ago, has since moved its headquarters to Wilmington. Its 80 members meet during the third week of each month. Last winter a series of public lectures was given at the YWCA, and will be repeated this fall.

Individuals in the group own 15 reflectors from six to 10 inches in aperture. The society's address is 1301 Orange St., Wilmington 1, Del.

NORTHWEST CONVENTION

The largest meeting in the history of the Northwest Region of the Astronomical League was held July 4-6, when 105 amateurs registered for our 11th annual convention. Sessions were held in the still uncompleted Oregon Museum of Science and Industry, in Portland. The sponsors were the Portland Astronomical Society and the Portland Amateur Telescope Makers and Observers.

The guest of honor was Dr. Joseph A. Pearce, former director of the Dominion Astrophysical Observatory, Victoria, British Columbia. His illustrated lecture on the Pleiades and his informal remarks at the banquet were highlights of the convention. Other noteworthy events were the planetarium demonstration by Norman Smale, the museum tour conducted by Dr. Douglas Hueggi, and the color film

and talk by George Hohnstein on the construction of his 6-inch refractor.

Regional officers for the coming year are: Charles D. Freeland, Portland, chairman; James W. Young, Seattle, vice-chairman; Mrs. Margaret E. Kobs, Portland, recording secretary; Norman C. Dalke, Seattle, executive secretary; Mrs. Lloyd Bolch, Spokane, treasurer; and the undersigned, regional representative.

The Tacoma, Washington, Amateur Astronomers will be hosts to the 1959 meeting.

EDWARD J. NEWMAN
324 W. Yakima Ave.
Yakima, Wash.

THIS MONTH'S MEETINGS

Cambridge, Mass.: Amateur Telescope Makers of Boston, 8 p.m., Harvard Observatory. October 9, telescope making round table.

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Health Museum Planetarium. October 27, Ted Gangl, "Various Phases of Astronomy."

Edinburg, Tex.: Magic Valley Astronomical Society, 8 p.m., Pan American College science building. October 24, Bell System science films.

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. October 1, Dr. Peter M. Millman, National Research Council of Canada, "Around the World with the IGY."

New York, N. Y.: Junior Astronomy Club, 8 p.m., Waverly building, New York University. October 17, Dr. Arthur E. Lilley, Yale University Observatory, "The Exploration of Space with Radio Waves."

Philadelphia, Pa.: Rittenhouse Astronomical Society, 8 p.m., Franklin Institute. October 10, Dr. F. J. Heyden, S.J., Georgetown Observatory, "Counting Stars and Galaxies."

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 5-2370.

SCHEDULE: (Sept.-June), Thursday, 7:15, 7:45, 9 p.m.; Saturday, 2 and 3 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BLOOMFIELD HILLS, MICH.: *McMath Planetarium.* Cranbrook Institute of Science, Bloomfield Hills, Mich.

SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m.; Wednesday, 4 p.m. Spitz projector. In charge, James A. Fowler.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR 4100.

SCHEDULE: Sunday, 2:30 to 5 p.m. (except summer). Admission free. Spitz projector. Director, Fred T. Hall.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N. C.

SCHEDULE: Sunday through Saturday, 8:30 p.m.; also at 11 a.m. and 3 p.m. Saturday, 3 and 4 p.m. Sunday. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Children's Museum, Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11 a.m. Admission free. Spitz projector. Director, Mrs. R. L. Sullivan.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Dr., Chicago 5, Ill., Wabash 2-1428.

SCHEDULE: Monday through Saturday, 11 a.m. and 3 p.m.; Tuesday and Friday, 8 p.m.; Sunday, 2 and 3:30 p.m. Zeiss projector. Director, Albert Shatzel.

DALLAS: *Dallas Planetarium.* Dallas Health Museum, Fair Park, Dallas 10, Tex., HA 8-8351.

SCHEDULE: Saturday and Sunday, 3 p.m. Spitz projector. Planetarium educator, Mrs. Claudia Robinson.

DENVER: *Denver Museum of Natural History Planetarium.* City Park, Denver, Colo., East 2-1808.

SCHEDULE: Saturday and Sunday, 1 to 4:30 p.m. Spitz projector. Curator, W. R. Van Nattan.

FLINT, MICH.: *Robert T. Longway Planetarium.* Flint Junior College, 1310 E. Kearsley St., Flint 3, Mich., Cedar 8-1631.

SCHEDULE: Tuesday through Friday, 7 to 9 p.m.; Saturday and Sunday, 8 p.m. Spitz Model B projector. Director, Maurice G. Moore.

FT. WORTH: *Charlie M. Noble Planetarium.* Ft. Worth Children's Museum, 1501 Montgomery, Ft. Worth, Tex., PE 2-1461.

SCHEDULE: Tuesday through Friday, 4 p.m.; Saturday, 11 a.m. and 2:30 p.m.; Sunday, 2:30 p.m. Spitz projector. Supervisor, Norman C. Cole.

INDIANAPOLIS: *Holcomb Planetarium.* Butler University, Indianapolis 7, Ind.

SCHEDULE: Saturday and Sunday, 4 and 8 p.m. Spitz projector. Director, Harry E. Crull.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 23, Mo., Humboldt 3-8000.

SCHEDULE: Saturday and Sunday, 3 p.m. Spitz projector. Director, Kenneth W. Prescott.

LANCASTER, PA.: *North Museum and Planetarium.* Franklin and Marshall College, Lancaster, Pa.

SCHEDULE: Tuesday and Thursday, 8 p.m.; Saturday and Sunday, 3 p.m. Admission free. Spitz projector. Curator, John W. Price.

LAQUEY, MO.: *Tarbell Planetarium.* Inca Cave Park, Laquey, Mo.

SCHEDULE: Sunday, 1 to 6 p.m., continuous. Spitz projector. Director, E. D. Tarbell.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Normandy 4-1191.

SCHEDULE: Daily (except Monday), 3 and 8:30 p.m.; also 1:30 and 4:15 p.m. Saturday and Sunday. Zeiss projector. Director, C. H. Cleminshaw.

MINNEAPOLIS: *Science Museum.* Minneapolis Public Library, 1001 Hennepin Ave., Minneapolis 3, Minn.

SCHEDULE: Saturday, 10 a.m. and 2 p.m. Admission free. Spitz projector. Planetarium director, Mrs. Maxine B. Haarstick.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., Chapel 2-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15 p.m. Spitz projector. Lecturer, Sam Smith.

NEWARK: *Newark Museum Planetarium.* 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday, Sunday (except first Sunday of month), and holidays, 2:30 and 3:30 p.m. Admission free. Spitz projector. Supervisor, Raymond J. Stein.

NEW YORK CITY: *American Museum-Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Monday, 2 and 3:30 p.m.; Tuesday through Friday, 2, 3:30 and 8:30 p.m.; Saturday, 11 a.m., 1, 2, 3, 4, 5 and 8:30 p.m.; Sunday and holidays, 1, 2, 3, 4, 5 and 8:30 p.m. Zeiss projector. Chairman, J. M. Chamberlain.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesday through Sunday, 3 p.m.; Saturday, 11 a.m.; Saturday, Sunday, and holidays, 2 p.m.; Wednesday and Friday, 8 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 1-4300.

SCHEDULE: Monday through Friday, 2:15 and 8:30 p.m.; Saturday, 11 a.m., 2:15 and 8:30 p.m.; Sunday, 2:15, 4:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PROVIDENCE: *Roger Williams Planetarium.* Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Saturday, Sunday, and holidays, 3 and 4 p.m. (Oct.-June). Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday), 3:30 and 8:30 p.m.; also 2 p.m. Saturday, Sunday, and holidays. Academy projector. Curator, George W. Bunton.

SAN JOSE, CALIF.: *Rosicrucian Planetarium and Science Museum.* Park Ave. and Naglee Ave., San Jose, Calif.

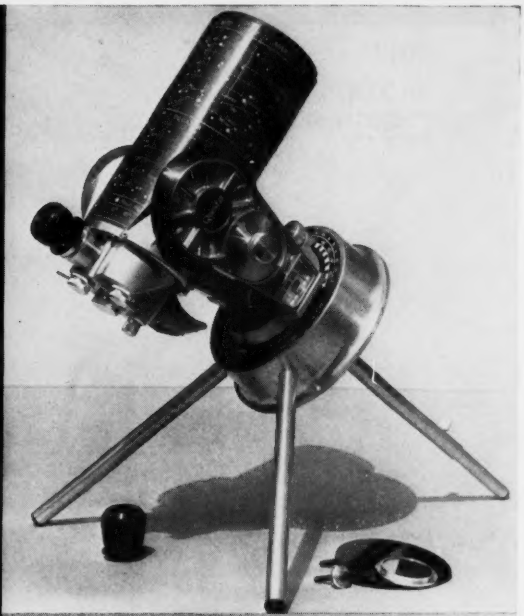
SCHEDULE: Sunday and Wednesday, 2 and 3:30 p.m. Spitz projector. Director, Rodman R. Clayson.

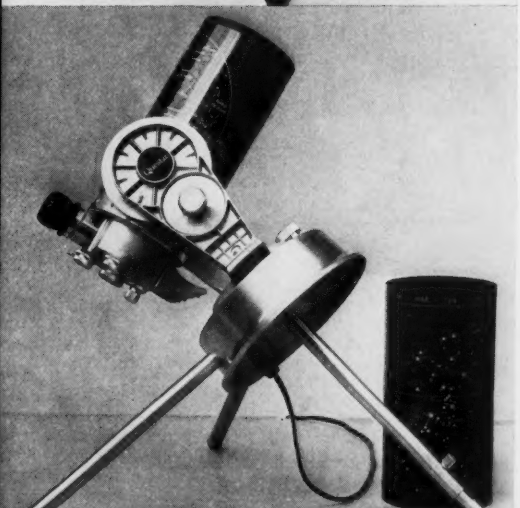
SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesday, Thursday, and Saturday, 3 p.m.; also 8:30 p.m. Tuesday; special star stories for children, Saturday, 2 p.m. Admission free. Korkosz projector. Director, F. Korkosz.

STAMFORD, CONN.: *Edgerton Planetarium.* Stamford Museum and Nature Center, Stamford, Conn., Davis 2-1646.

SCHEDULE: Saturday, 11 a.m.; Sunday, 4 p.m. Spitz projector. Director, Ernest T. Luhde.





OBSERVER'S PAGE

Universal time (UT) is used unless otherwise noted.

Observing the Moon — Pitatus

PROMINENTLY located on the extreme southern shore of Mare Nubium, Pitatus is a large lagoonlike formation about 66 miles in diameter. This noticeably hexagonal walled plain has a complex inner structure. Its interior walls exhibit some of the finest examples of terraces and landslips to be found on the entire lunar surface.

Except on the northern side, the ramparts of Pitatus are rugged, with large numbers of small craters lying on the crest. Of these, Pitatus G on the west rim is of special interest. It is shallow, with a rather smooth dark floor, from which at least three dusky bands extend south and east to its rim. Pitatus G is thus a good example of one class of banded crater.

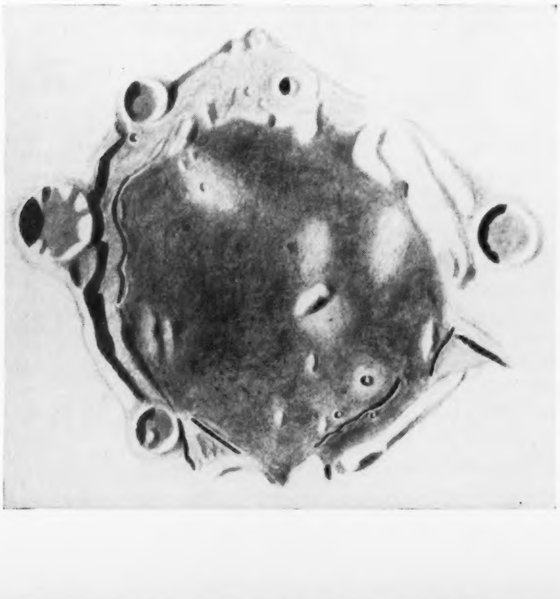
Like many other craters lying adjacent to lunar seas, the walls of Pitatus on the seaward (northern) side are ruined. Here the ramparts are merely a series of hills and low mounds, interspersed with narrow gaps and passes leading into the crater interior. These continue along the northeast wall, terminating with a valley which enters Hesiodus, the large crater northeast of Pitatus.

Except for several light spots and streaks, the interior of Pitatus has a shade very similar to that of neighboring Mare Nubium. This fact suggests that at one time lava from this sea overflowed its walls and invaded the interior. With the exception of one fairly prominent hill near the center and a few scattered low mounds, the floor is comparatively smooth. It does, however, contain a number of craterlets, most of them visible only with fairly large telescopes under excellent seeing conditions. H. P. Wilkins estimates there are about 40 of these little craters.

One of the most interesting features of Pitatus is the intricate system of clefts on its floor. Many are concentric with the walls, like the Posidonius clefts described on page 464 of the July issue. A discontinuous series of easily seen clefts begins near the base of the northeast wall, close to the pass into Hesiodus, and proceeds to the north and as far as the west wall. From this point, a long cleft may be traced, under favorable evening lighting, completely around the rest of the floor.

The clefts just mentioned should not be difficult to observe with comparatively small telescopes. Others are not so easy. Under excellent seeing conditions I have seen an exceedingly delicate cleft beginning near the foot of the west wall, just north of Pitatus G, and extending northeast across the floor until it ended near the interior slope just north of the Hesiodus pass. This cleft was seen by me only once and should be looked for by other observers, as it may be a hitherto unreported feature.

ALIKA K. HERRING
3273 Liberty Blvd.
South Gate, Calif.

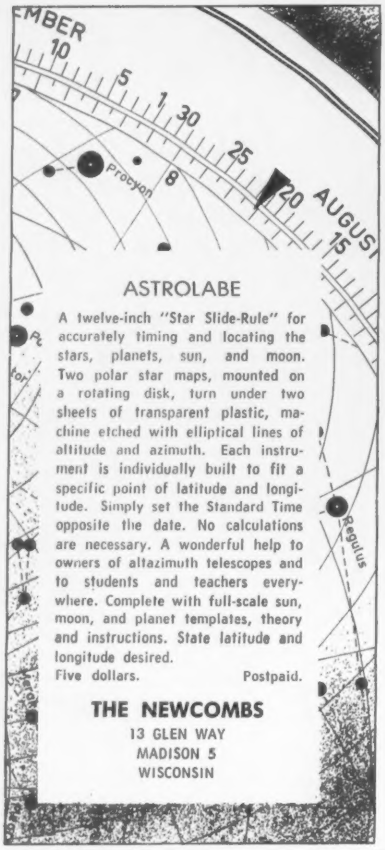


The lunar crater Pitatus, drawn three days after first-quarter moon by Alika K. Herring. He used a 12½-inch reflector, power 310x, on January 1, 1958, at 5:15 UT. It was then morning in Pitatus; however, the solar altitude was about 20 degrees, and the mile-high western ramparts of Pitatus and Pitatus G (extreme left) cast relatively short shadows. South is at the top, west to the left.

DEEP-SKY WONDERS

AS ANDROMEDA moves toward the meridian, two of the brightest spiral galaxies, Messier 31 and 33, are high in the eastern sky. The former is the Great Nebula in Andromeda, described in almost every book on astronomy; it lies a few degrees above Mirach (β Andromedae), at right ascension $0^h\ 40^m.0$, declination $+41°\ 00'$ (1950 co-ordinates).

So conspicuous to the naked eye is this spindle of light that it is odd the ancients did not mention it. As with comets, it appears to have larger dimensions to the naked eye or through binoculars than when viewed with medium-sized telescopes, and the published values for its

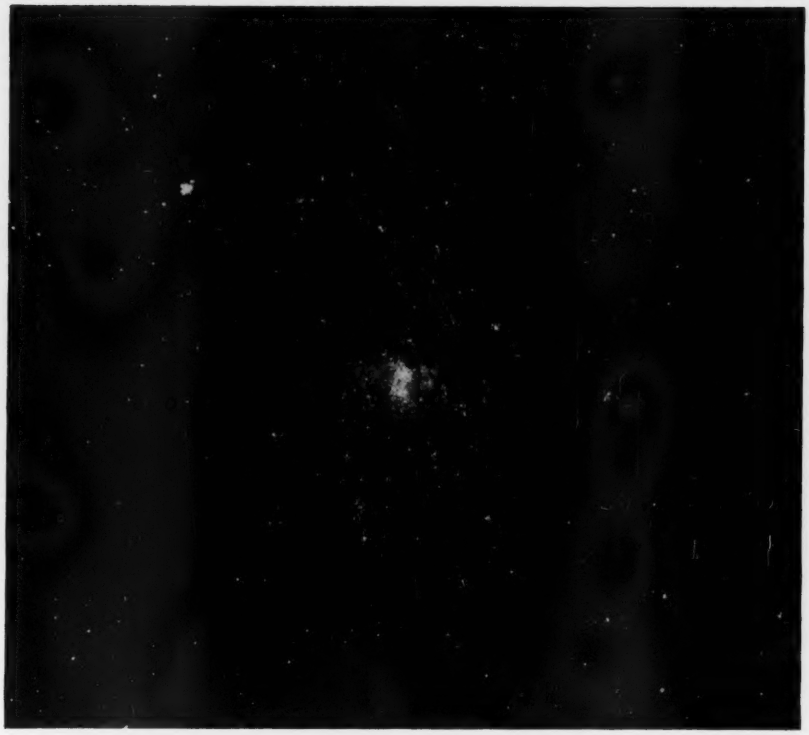


Two decades ago Harvard astronomers plotted these circles $2\frac{1}{2}$ degrees from the nucleus of M31 to indicate regions of surface brightness equal to that in our galaxy at the then assumed position of the sun relative to the galactic center. From "The Telescope," July-August, 1940.

size vary widely. Photoelectric observations and microdensitometer tracings of photographic plates indicate that M31 is about five degrees long – almost twice as large as photographs suggest to the eye.

The writer remembers the work of Lynn Mathais, a Milwaukee amateur, who took a photograph of M31 with his 6-inch reflector back in the 1930's. He then ran the plate through a homemade photometer to show the extensions along the principal axis of the galaxy just as professional astronomers had done.

But an amateur cannot do so well for another characteristic of this great object. Its spiral structure, first recognized



The galaxy in Triangulum, M33, is a late-type spiral with a very small nucleus and loose arms, as shown by this exposure of only 14 minutes, made by John C. Duncan with the 100-inch Mount Wilson telescope to show details of the inner regions of the system.

by Lord Rosse, probably cannot be seen in amateur instruments despite a few claims to the contrary. I would like to hear from amateurs who have been making detailed observations of the Andromeda spiral.

In a really clear sky without moonlight, M33, the spiral nebula in Triangulum, is also visible to the naked eye. This opinion may evoke the dismay of hundreds of amateurs who have unsuccessfully searched for this galaxy, which is located at $1^h\ 31^m.1$, $+30°\ 24'$, not far from α Trianguli. However, whenever stars as faint as magnitude 6.0 can be seen in that area of the sky, M33 is a naked-eye reward for the careful observer. If the stellar magnitude limit is 6.5, this object becomes easy. The writer once saw it out of the corner of his eye on a clear night and thought for a moment it was a small patch of cloud!

In telescopes, M33 is difficult to see because its disk of nearly a degree diameter shines almost uniformly. M31 is considerably brighter toward its center, but M33 is practically featureless. The surface brightness is low, and an observer may have his field of view centered on the nebula without realizing it — he mistakes the galaxy for mere sky background. If M33 just fits into your field of view, you will probably miss it, so keep the power low and the field large.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

AURORA OF SEPTEMBER 4-5

Another in 1958's series of spectacular displays of northern lights was widely viewed by amateur astronomers on the evening of Thursday, September 4th. At Washington, D. C., Patrick Moretti made a series of six pastel drawings to record the course of the phenomenon.

He began observing at 8:15 p.m. Eastern standard time, when nearly the whole sky was covered with a reddish glow, which faded. About 10 p.m. the display became bright enough to blot out Deneb, the northern sky being covered with bright rays extending from the horizon to beyond the zenith. The rising of the last-quarter moon around midnight brought an end to the show, although auroral activity was evident until as late as 2:30 a.m.

Observations by the Kingsport, Tennessee, Astronomical Society were reported by its president, James Brown. Two maxima of activity were noted, at 8:17 p.m. and 10:25 p.m., when the aurora reached an altitude of about 75° in the north-northeast. At Salisbury, North Carolina, Jesse Watson recorded the early stages of the September 4th aurora as a fairly bright reddish glow.

Ed Pape, at Louisville, Kentucky, first noted the aurora at 7:55 p.m. EST, then consisting of two reddish patches in the east. He took several photographs and kept a visual watch until midnight. In the same city, C. J. Lipschutz and K. P. Howe, Jr., described the aurora at 8:15 as red, reaching to an altitude of 60°. Both observers are members of the Louisville Junior Astronomical Society.

The same display was recorded as greenish by J. R. Otoupalik, Greeley, Colorado. A. J. Hartzler, Oceanport, New Jersey, described the corona as blue-white.

At St. Aubin de Courteraie, France, P. Bourge photographed auroral activity on September 4th. He is secretary of the Astronomical Society of Normandy.

SUNSPOT NUMBERS

The following American sunspot numbers for July were derived by Dr. Sarah J. Hill of Whitin Observatory, Wellesley College, from AAVSO Solar Division observations.

July 1, 180; **2**, 168; **3**, 192; **4**, 206; **5**, 225; **6**, 223; **7**, 185; **8**, 162; **9**, 185; **10**, 175; **11**, 149; **12**, 120; **13**, 135; **14**, 104; **15**, 132; **16**, 127; **17**, 147; **18**, 142; **19**, 176; **20**, 187; **21**, 204; **22**, 158; **23**, 185; **24**, 198; **25**, 162; **26**, 188; **27**, 181; **28**, 189; **29**, 206; **30**, 250; **31**, 283. Mean for July, 178.2.

Below are observed mean relative sunspot numbers from Zurich Observatory and its stations in Locarno and Arosa.

August 1, 279; **2**, 250; **3**, 210; **4**, 177; **5**, 198; **6**, 209; **7**, 223; **8**, 230; **9**, 265; **10**, 255; **11**, 271; **12**, 228; **13**, 220; **14**, 202; **15**, 190; **16**, 177; **17**, 163; **18**, 152; **19**, 128; **20**, 131; **21**, 145; **22**, 160; **23**, 200; **24**, 177; **25**, 207; **26**, 180; **27**, 196; **28**, 202; **29**, 238; **30**, 238; **31**, 220. Mean for August, 203.9.

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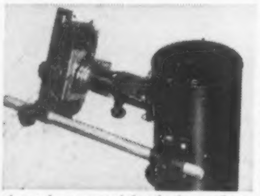

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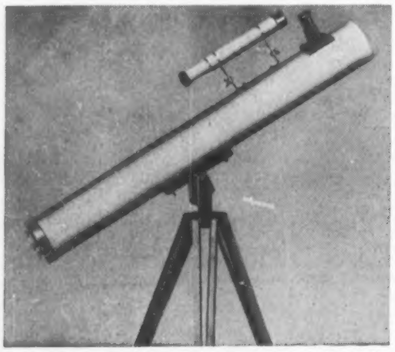

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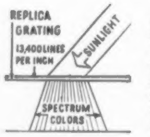

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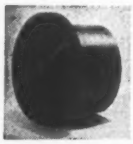

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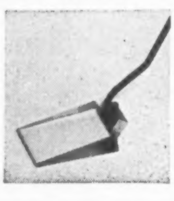

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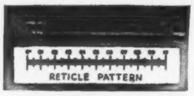

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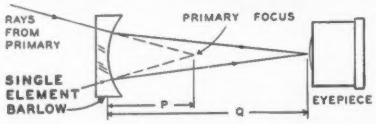
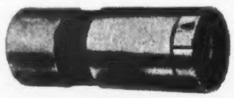


WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q.



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of −1-5/16". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens.......$8.00 ppd.

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, focal length 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y......$7.95 ppd.

EDMUND SCIENTIFIC CO.

BOOKS AND THE SKY

THE PLANET JUPITER

Bertrand M. Peek. The Macmillan Co., New York, 1958. 283 pages. $8.50.

ANY professional or amateur astronomer having serious observational or theoretical interest in Jupiter will find this book indispensable. What Gerard de Vaucouleurs has so splendidly achieved in his *Physics of the Planet Mars,* Bertrand M. Peek, for many years director of the Jupiter section, British Astronomical Association, has now accomplished for the giant planet in what will surely be a classic for many years to come.

The author has compiled a great amount of valuable material previously scattered through various journals, many of them difficult to find. The text is reliable and remarkably free from errors, and the style of writing is clear and easy to follow without being "popular" in the trivial sense. The illustrations and diagrams are well chosen to assist the presentation and are of good quality, including some dozens of drawings of part or all of the planet by skillful members of the BAA Jupiter section.

After several introductory chapters, visual methods of studying Jupiter are explained: drawings, color estimates, latitude measurements, and central meridian transits. There follows a description of the different longitudinal currents, beginning with those near the north pole.

Features on the planet of special interest are then discussed, all of them lying in the restricted range of Jovian latitude from five to 35 degrees south: the great red spot, the south tropical disturbance of 1901-40, the major outbreaks of activity in the south equatorial belt, the circulating current in the south tropical zone, two oscillating spots in the same zone in 1940 and in 1941-42, the dark south tropical streaks of 1941-42 and 1946-47 [also 1955-57], the long-lasting dark and light portions of the south temperate zone observed from 1940 to the present, and the apparent sources of radio emission now under study. There is nothing comparable in Jupiter's northern hemisphere.

The final chapters present some stimulating theoretical considerations, as well as a description of the satellites and the phenomena of the four bright ones.

Most of the book is based upon visually observed central meridian transits of the surface markings. As emphasized several times, these form a quantitative method of investigation and do not rest upon the subjective interpretation of planetary detail near the limit of visibility.

Central meridian transits should be observed much more earnestly by American amateurs. The equipment required is only a telescope and a watch; some results can be obtained with as little as three or four inches of aperture, though a larger instrument will reveal many more markings. One simply records, to the nearest minute, the moment at which the rotation of Jupiter carries each surface feature past the meridian of longitude through the center of the disk – in other words, when the spot is midway between the east and west limbs.

An experienced observer can usually record this time with an error of only two or three minutes, and if the feature can be kept under observation for a month, its rotation period may be deduced with an error of only a few seconds at most. The reduction of the observations involves computing the longitude of each feature from suitable tables, plotting longitudes of markings as a function of time (date), and the drawing of drift curves on this graph. The latter process can be tricky when a region is very active and subject to rapid changes.

Mr. Peek seems rather skeptical of the value of color estimates and explains how atmospheric dispersion can introduce false colors on a belted planet. If, during Jupiter's 12-year period, only observations from one hemisphere of the earth are considered, the color factor may mask any existing Jovian seasonal effects. Perhaps the point is labored too heavily. Atmospheric dispersion will act along the vertical circle in the sky through the position

of Jupiter (with occasional exceptions very near the horizon). When the planet is not close to the observer's meridian, this circle can be oriented very far from the perpendicular to the belts, as it must be approximately to produce the spurious colors.

Although we hold the work of the Jupiter section of the BAA in the highest esteem, the book is excessively preoccupied with its results. European studies are ignored, and very few American amateurs are even mentioned.

The ideal Jupiter observing group of the future should be world-wide. Only by such a large distribution can we obtain effective coverage of all longitudes of the giant planet, especially when it is close to conjunction and can be viewed usefully at a given place for only an hour or two. Thus, the gaps in our records of important Jovian spots, often mentioned by Mr. Peek as the result of prolonged bad weather in the British Isles, would be avoided.

Four appendices give a method of reducing latitude measurements, a formula for computing the central meridian transit of a satellite shadow, the tabulated amount of rotation as a function of time in the two systems of Jovian longitude, and tables of rotation periods in these two systems as a function of change of longitude in 30 days.

WALTER H. HAAS
Association of Lunar and
Planetary Observers
1835 Evans Place
Las Cruces, N. M.

LIGHT: VISIBLE AND INVISIBLE

Eduard Ruechardt. University of Michigan Press, Ann Arbor, Mich., 1958. 201 pages. $4.50.

LIGHT is the most useful octave in the electromagnetic spectrum. Appreciated and utilized by everyone, it remains the great mystery in spite of the constant endeavor of great minds to unravel its nature. Like gravity, it challenges man.

This new book on light stays close to the classic outlook. Written for the general reader, it avoids the starkness of textbooks that usually discourages after-school reading. This pocket-size translation by Frank Gaynor contains 15 chapters that compress the subject into 200 pages, which are saturated with illustrations.

The Greeks thought sight worked like a sniperscope: Something went out from the eye, touched the object, and returned with the information. Night and day sight must have been difficult to explain with this theory! The first chapter of the book uses sound waves to illustrate and propound the wave side of the problem of the nature of light. In the second chapter, geometrical optics are presented without stopping the reader with mathematical symbols.

The chapters on diffraction and interference will help the camera fan understand the iris on his lens better, and everyone will see why light was called a wave action for so long. Michelson's interferometer and the measuring of stellar diameters will appeal to the amateur astronomer, while the pages on invisible glass and interference filters are good general information.

Polarization and double refraction are nicely described, with photoelasticity being used as a practical application. The phenomenon of dispersion illustrates the fact that the velocity of light varies with

different media. Rainbows and prismatic spectra are common examples.

The pages on color will clear up some misconceptions, and will explain the action on light of filters, paints, and dyes. The discussion of infrared and ultraviolet light, along with their applications, justifies the second part of the book's title.

The use of the spectrum in astronomy is brought out clearly in the section on spectral lines, which shows how one discovery can expand the entire field of science. A long chapter on electromagnetic radiation tells why the concept of ether was discarded. Maxwell and Hertz, together with Faraday, put light and electricity under the same roof – here is some pure science to add to the enjoyment of your radio or television set.

Very recent observations made by artificial satellites indicate that X-rays may offer a barrier to the space traveler. The author covers the physical character of such extremely short-wave radiation and shows how X-rays are unknown no longer. If the light side of your life needs focusing, and you have fear of such things as X-rays, read this outline as a pre-spaceflight need.

EDWIN F. BAILEY
Franklin Institute
Philadelphia 3, Pa.

INTRODUCTION TO THE MOON

Dinsmore Alter. Griffith Observatory, P. O. Box 27787, Los Angeles 27, Calif., 1958. 108 pages. $1.65, paper bound.

DR. ALTER, who recently retired from the directorship of the Griffith Observatory in Los Angeles, California, has been actively interested in the moon for many years. He has written a small book that should be of special interest to all amateur astronomers, from beginners to dyed-in-the-wool selenographers.

Unquestionably this is the best illustrated of any recent popular works on the moon. There is a magnificent series of 62 photographs, some selected from the nearly 350 infrared plates taken by the author with the Mount Wilson 60-inch reflector, the others from the fine pictures secured by J. H. Moore and J. F. Chappell with the Lick 36-inch refractor.

Much of the text is a simply written, thoughtful survey of the different types of surface formations, such as maria, walled plains, crater pits, and domes. A good deal of this material previously appeared in a series of articles by Dr. Alter in the *Publications* of the Astronomical Society of the Pacific. Other chapters tell briefly the history of selenography, about tides, and the potential uses of an observatory on the moon.

The vexing question of the origin of the moon's surface features is discussed soberly and with close attention to the observational facts that any satisfactory theory must explain. In particular, Dr. Alter gives useful listings of the observed properties of the different classes of formations, making his account superior in this respect to H. P. Wilkins and P. A. Moore's *The Moon.*

The amateur whose library is limited will welcome the key chart on pages 20 and 21, which allows easy identification of every formation mentioned in this book. Thus the work is entirely self-contained, and can be read without reference to other books or charts.

Dr. Alter devotes nearly a page to a discussion of the historic 0-to-10 scale for visual estimates of the brightness of lunar features. On this scale, 0 represents black, 5 light gray, 8 white, and 10 dazzling white. If the nature of this scale is properly understood, it is a useful tool for visual

observers. But the author has omitted the following facts.

With a few possible exceptions, every portion of the moon's disk brightens continually from sunrise to full moon (strictly, zero phase angle) and then fades to sunset. The flat statement, "Linne is of brightness $5\frac{1}{2}$," has no physical significance, because the actual brightness is changing throughout the lunation. It is, however, meaningful to record that at a certain phase Linne appeared two steps brighter than the surrounding mare. Only at full moon does the 0-to-10 scale have any straightforward meaning, for only then is it simply related to the albedos of individual features. Because of widespread misconceptions about these matters, it is unfortunate that Dr. Alter did not clarify them.

Introduction to the Moon is easily the best general account of our satellite in popular language. It can be regarded as complementing the Wilkins and Moore book, which is rich in topographical description, but weak in its summarizing chapters.

J.A.

CORRECTION

In the diagram on page 584 last month, which was relettered from the original in the book, *The Astronomer's Universe,* by Bart J. Bok, an error in labeling the color index scale was introduced. The label +.6 should read +.8.

NEW BOOKS RECEIVED

PHYSICS AND PHILOSOPHY, *Werner Heisenberg*, 1958, *Harper*. 206 pages. $4.00.

A German winner of the Nobel physics prize discusses the impact of quantum theory and relativity on modern thought, both physical and social. His essay is intended for the layman with some background in physics, rather than a specialist in the philosophy of science.

HOW ABOUT THE WEATHER? *Robert Moore Fisher*, 1958, *Harper*. 172 pages. $3.75.

An understanding of weather elements and forecasting is offered to laymen by this popularly written and copiously illustrated account. Many actual weather occurrences are described, and the discussion is enlivened by weather proverbs. This revision of the 1951 edition contains new material on weather maps, the jet stream, hurricanes, and long-range forecasts.

THE EXPLORATION OF TIME, *R. N. C. Bowen*, 1958, *Philosophical Library*. 143 pages. $6.00.

Methods of finding the ages of rocks, fossils, and prehistoric artifacts are briefly surveyed. The author tells how sciences as diverse as astronomy and genetics enter into the field of geochronology.

ASTRONOMISCHER JAHRESBERICHT, Vol. 56, 1958, *Astronomisches Rechen-Institut*, Heidelberg, West Germany. 503 pages. DM 60, paper bound.

The world's astronomical literature published in 1956 is comprehensively listed in this latest annual volume of a standard reference work. Titles are arranged by subject, with short abstracts in German for the more important references. The alphabetical subject index is in English.

COSMIC ELECTRODYNAMICS, *J. W. Dungey*, 1958, *Cambridge University Press*. 183 pages. $6.00.

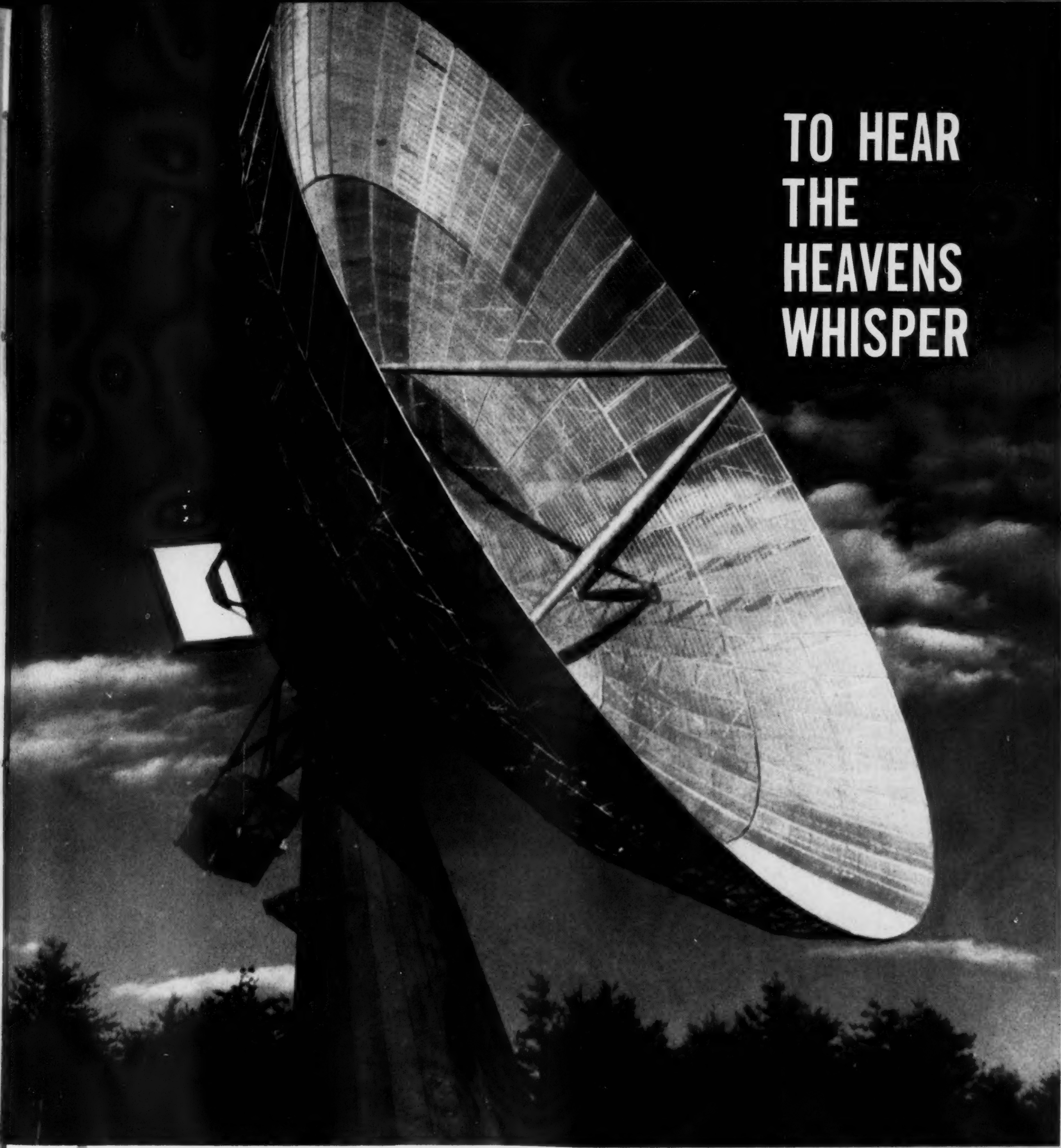
Increasing awareness of the importance of electromagnetic fields in astrophysics has prompted this monograph, which deals with the subject's theoretical aspects. The approach is mathematical, and particular stress is laid on solar phenomena, cosmic rays, geomagnetic storms, and aurorae.

ISAAC NEWTON'S PAPERS & LETTERS ON NATURAL PHILOSOPHY, *I. Bernard Cohen*, editor, 1958, *Harvard University Press*. 501 pages. $12.50.

Collected here in facsimile form with notes are more than 20 of Newton's shorter publications on optics, chemistry, and astronomy. Among them is a reprint of his 1672 announcement of the invention of a reflecting telescope. Other material includes Newton's correspondence with Bentley, and his biography by Fontenelle of 1728. There are extensive commentaries.

APPARENT PLACES OF FUNDAMENTAL STARS 1959, 1958, *Her Majesty's Stationery Office*, York House, Kingsway, London W. C. 2, England. 536 pages. £2 2s.

As before, this annual volume carries apparent positions of bright stars, giving right ascensions to 0.001 second and declinations to 0".01, at 10-day intervals, for 1,535 stars. Published this year for the last time in London, the book next year will be issued by the Astronomisches Rechen-Institut in Heidelberg, West Germany, with no changes in content or presentation. In the United States, the current edition can be ordered for $7.82 from British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.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THE
HEAVENS
WHISPER

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3¼″ diam., 48″ f.l. (uncoated) **$28.00**	4⅛″ diam., 62″ f.l. (uncoated) **$60.00**
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We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼″ focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm. (2⅛″)	254 mm. (10″)	$12.50	83 mm. (3¼″)	660 mm. (26″)	$28.00
54 mm. (2⅛″)	300 mm. (11.8″)	12.50	83 mm. (3¼″)	711 mm. (28″)	28.00
54 mm. (2⅛″)	330 mm. (13″)	12.50	83 mm. (3¼″)	762 mm. (30″)	28.00
54 mm. (2⅛″)	390 mm. (15.4″)	9.75	83 mm. (3¼″)	876 mm. (34½″)	28.00
54 mm. (2⅛″)	508 mm. (20″)	12.50	83 mm. (3¼″)	1016 mm. (40″)	30.00
54 mm. (2⅛″)	600 mm. (23½″)	12.50	102 mm. (4″)	876 mm. (34½″)	60.00
54 mm. (2⅛″)	762 mm. (30″)	12.50	108 mm. (4¼″)	914 mm. (36″)	60.00
54 mm. (2⅛″)	1016 mm. (40″)	12.50	110 mm. (4⅜″)*	1069 mm. (42-1/16″)	60.00
54 mm. (2⅛″)	1270 mm. (50″)	12.50	110 mm. (4⅜″)	1069 mm. (42-1/16″)	67.00
78 mm. (3-1/16″)	381 mm. (15″)	21.00	128 mm. (5-1/16″)*	628 mm. (24¾″)	75.00
80 mm. (3⅛″)	495 mm. (19½″)	28.00	128 mm. (5-1/16″)	628 mm. (24¾″)	85.00
81 mm. (3-3/16″)	622 mm. (24½″)	22.50	*Not coated		

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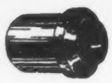
LOW-PRICE EYEPIECE



27-mm. E.F.L. Standard Kellner (wide-field) eyepiece offered in 1¼″ black-anodized aluminum mount. Here is an astronomical eyepiece at a truly down-to-earth price. (For coated optics add 75 cents.) **$4.50 ppd.**

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These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon-monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3-3/16″	42″	$ 9.75
Pyrex	4¼″	45″	13.50
Pyrex	6″	60″	25.00

MIRROR MOUNT

Cast aluminum. Holds all our mirrors firmly with metal clips. Completely adjustable. Assembled, ready to use.

3-3/16″	Mirror Mount fits our 4½″ tubing	$4.00 ppd.
4¼″	Mirror Mount fits our 5″ tubing	4.00 ppd.
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Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼″	2⅛″	$1.20 ppd.
3⅜″	3¼″	1.75 ppd.
4½″	4⅜″	2.50 f.o.b.
5″	4⅞″	2.25 f.o.b.
7″	6⅞″	3.00 f.o.b.

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The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼″ eyepieces.

For 2⅛″ I.D. Tubing	Postpaid	$12.95
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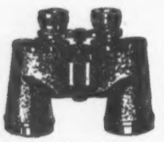

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Size	Field at 1,000 yards	Type	Center Focus	Ind. Focus
6 x 15	360 ft.	Opera	—	$12.75
6 x 30	395	"Zeiss"	$18.75	16.75
7 x 35	341	"Zeiss"	21.25	19.25
7 x 35	341	American	23.50	—
7 x 35	578	American Wide Angle 11°	37.50	—
7 x 50	372	"Zeiss"	24.95	22.50
7 x 50	372	American	32.50	—
8 x 30	393	"Zeiss"	21.00	18.25
10 x 50	275	"Zeiss"	30.75	28.50
20 x 50	183	"Zeiss"	41.50	39.50

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Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	$10.00	7 x 50	$14.75
8 x 30	11.25	16 x 50	17.50
7 x 35	12.50	20 x 50	20.00

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

90° RIGHT-ANGLE PRISMS

8-mm. face	$1.00		
12-mm. face	1.00		
23-mm. face	1.25	Silvered	$2.00
28-mm. face	1.75	Silvered	2.50
38-mm. face	2.00	Silvered	2.75
48-mm. face	3.00	Silvered	4.00

62-mm. face, coated **$17.50**

SPECIAL COATED OBJECTIVE BIG 2⅛″ DIAM. — 40″ F.L. — $6.00

These achromatic objective lenses are tested and have the same high quality as "Big Lenses" described above, except they are seconds for slight edge chips or small scratches only. Quality guaranteed. **ONLY $6.00 ppd.**

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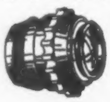
ERFLE EYEPIECE (65° field) contains 3 coated achromats. 1½″ E.F.L., clear aperture 2⅛″. Has a focusing mount with diopter scale. Will make an excellent 35-mm. Kodachrome Viewer. Magnifies seven times ...... **$12.50 ppd.**

Same as above without diopter scale **$9.95**



WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new; coated 1¼″ E.F.L. Focusing mount. 3 perfect achromats, 1-13/16″ aperture **$13.50**

WIDE ANGLE ERFLE 1½″ E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2″; focusing mounts; 65° field **$12.50**

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LENS CLEANING TISSUE — Here is a wonderful Gov't. surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications. 500 sheets size 7½″ x 11″ **$1.00**

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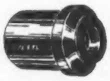

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black-anodized standard aluminum 1¼″ O.D. mounts.

F.L.	TYPE	PRICE
6 mm. (¼″)	Ramsden	$ 4.75
12.5 mm. (½″)	Ramsden	4.50
12.5 mm. (½″)	Symmetrical	6.00
16 mm. (⅝″)	Erfle (wide angle)	12.50
16 mm. (⅝″)	Triplet	12.50
18 mm. (¾″)	Symmetrical	6.00
22 mm. (27/32″)	Kellner	6.00
32 mm. (1¼″)	Orthoscopic	12.50
35 mm. (1⅜″)	Symmetrical	8.00
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56 mm. (2¼″)	Symmetrical	6.00

COATED LENSES 75 cents extra.

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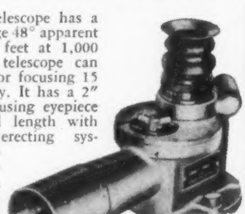

8 x 50

This M-17 telescope has a brilliant-image 48° apparent field — 325 feet at 1,000 yards. The telescope can be adjusted for focusing 15 feet to infinity. It has a 2″ objective, focusing eyepiece 28-mm. focal length with an Amici erecting system. Turret-mounted filters: clear, red, amber, and neutral. Lamp housing to illuminate reticle for night-time use. Truly the biggest bargain you were ever offered. Original Gov't. cost $200.

BARGAIN PRICE ...... **$13.50 ppd.**

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CONDUCTED BY ROBERT E. COX

Newtonian Focus Position and Parfocal Eyepieces

HOW FAR should the focal plane be placed outside the tube of a Newtonian telescope? The difficulty many amateurs have in focusing eyepieces of different powers comes from failure to answer this question properly in designing the diagonal and eyepiece holder parts of their instruments.

Whatever position is chosen for the focal plane is a compromise, for the following factors must be considered:

1. The diagonal should be as small as possible to minimize light loss and diffraction effects.

2. When short-focus eyepieces are used, the adapter tube should not extend into the light path within the main telescope tube, as such a condition causes added diffraction effects.

3. If the observer's eye has to be placed close to the main tube, the latter may interfere with observing comfort, especially on cold winter nights.

4. If the observer's head is too close to the main tube when using a short eyepiece, the finder may interfere, even though it is otherwise conveniently placed.

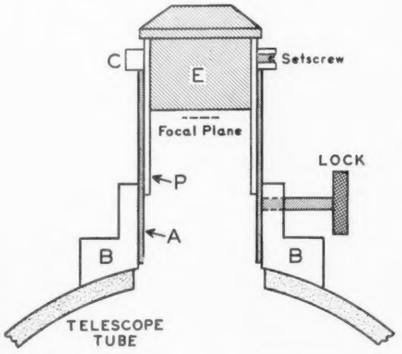
5. Eyepieces of focal lengths from $\frac{1}{4}''$ to $2''$ are in general use.

6. If a Barlow lens is used to obtain high magnifications with eyepieces of medium power, it must be placed inside the primary focus, and the higher the power, the farther inside.

7. Two positive eyepieces of the same focal length but different design or manufacture may focus at different distances from the focal plane.

8. It is a great observing convenience to be able to change eyepieces without refocusing, particularly when a faint object has been located with low power but is to be examined with high power.

9. Temperature changes during a long observing period may cause a change in the position of the focal plane.



The assembly of a parfocal eyepiece mounting. Sliding tube A is locked to base B. Eyepiece E is inserted in tube P so that C rests on top of A.

10. A change of observer usually requires a change of eyepiece focus.

As factor 1 is stressed in telescope making instructions and is in general of considerable importance, many amateur instruments are built with the final focus only an inch or even less outside the telescope tube. As a result, short-focus eyepieces often cannot reach the focal plane, or if they do factor 2 is involved.

Factors 2 to 6 all indicate that for ordinary use the focal plane should be $2''$ outside the tube, and few observers will object to a distance of $2\frac{1}{2}''$. Under average conditions, the difference in diagonal size is negligible. With a $7''$ tube and a focal length of $49''$, a $\frac{1}{2}''$ fully illuminated field of view can be obtained by placing the diagonal's center $5\frac{1}{2}''$ from the focal plane. Yet the small flat's minor axis will be only 1/10 inch longer than if this distance were $4\frac{1}{2}''$, and the additional light loss is under one per cent.

In designing the eyepiece holder (and rack and pinion if one is used), decide upon the minimum focal length of eyepiece you will use, 6-millimeter ($\frac{1}{4}$-inch) or less. If this eyepiece can be focused without being too close to the tube and without any interference with the light path in the telescope itself, then all longer oculars should work without trouble.

Check also the expected Barlow lens arrangement (factor 6). While a positive eyepiece, which is the kind that should be used on all standard reflectors, has its focal plane outside the front element, a Barlow negative lens is placed inside the primary focus. However, the suggested $2''$ distance should take care of Barlows giving 2x or 3x amplification.

For factors 7 and 8, the convenience of *parfocal* eyepieces should not be overlooked. Two eyepieces are parfocal if they are mounted in such a way that they may be interchanged at the telescope without a change of focal adjustment. Some manufacturers offer sets of parfocal oculars, but it is a simple matter to adapt a group of miscellaneous eyepieces so they may be interchanged in this manner.

Consider factors 9 and 10, however, before deciding on a method of parfocalizing your eyepieces. Since temperature changes cause a variation in the primary mirror's focal length, some provision for adjusting focus is needed. If other observers use the telescope frequently, they may need different focal settings. And it may be desired to use the eyepieces on another amateur's instrument from time to time.

It is possible to make a set of eyepieces parfocal by putting retaining rings on the eyepiece tubes themselves, and this is the method manufacturers usually use. But, for the reasons given above, this may

prove inconvenient unless a rack-and-pinion or spiral focusing device is included in the eyepiece assembly. Otherwise, the following procedure is recommended.

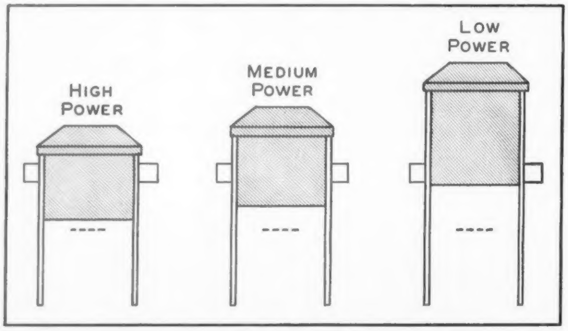
Eyepiece holders usually consist of a base mount attached to the telescope tube, an adapter tube and the eyepiece itself, with a standard size of $1\frac{1}{4}''$ outside diameter. For the parfocal arrangement, there are two sliding tubes, **P** and **A** in the diagram, which may require that a larger hole than the usual $1\frac{3}{8}''$ diameter must be put in the base mount **B.** There is a separate tube **P** for each eyepiece, as well as a collar **C** with a setscrew or clamping device.

Since the highest power eyepiece will focus closest to the primary image, its tube **P** will extend deepest into **A** and it should be set first. Insert **E** into **P** fully so the top cell flange rests against the top of the wall of **P.** Fix the collar **C** around **P** close to the top of the tube and fasten the setscrew tightly. Place **P** in **A** until the collar rests against the end of **A** and slide the latter into the base mount **B,** bringing a bright star into focus.

The base mount should have some sort of setscrew or clamp to hold tube **A** fixed in position once the focus is obtained. This arrangement must be convenient, as it will be necessary to adjust the focus fairly often.

Remove the high-power eyepiece assembly from the adapter tube. In turn, place each eyepiece and its tube **P** into the fixed tube **A;** with the collar **C** loose on **P** bring the bright star into focus by sliding **P** within **A.** Slide **C** until it is in contact with the top edge of **A,** tightening the setscrew so the collar forms a stop for this position of the eyepiece.

The eyepieces have now been made



A set of parfocal eyepieces for the amateur. It is recommended that the tube lengths be made proportional to focal length, as shown, to insure a steady seat in the adapter tube and to help identify oculars in the dark. Notice that the collars on the adapter tubes are equidistant from the focal plane (dashed line).

parfocal, and even a change in the setting of the adapter tube to compensate for temperature or other factors will not affect eyepiece interchangeability. It is a good idea to check the focus with the highest power eyepiece several times a night; if it needs changing loosen the **B** clamp and adjust tube **A** until the image is again as sharp as possible. This procedure must be followed each evening at the start of an observing session.

This method of parfocalizing has the advantage that the eyepieces themselves are not modified and may be used in any other instrument without change.

R. E. C.

A RIGID PIER

TRIPOD MOUNTINGS are difficult to orient and level accurately, yet these operations are important when setting up an equatorial telescope. Tripods are often unsteady, and the legs interfere with observations near the zenith. Therefore, I decided to build a durable but inexpensive pier, which has proven very satisfactory.

Not far from my house I selected a level site for the observing platform. This is a slab of poured concrete 4" thick and 15' across, octagonal in shape. In its center is a reinforced concrete pillar 31" high. This was shaped with a form of iron stovepipe, 8" in diameter, which was cut

To insure a permanently aligned and vibration-free support, J. Eyster placed his mounting on a concrete pillar 8" in diameter, with a platform around it 4" thick of the same material.

away after the material had set solidly.

The reinforcements of the pillar are three long ½" iron pipes, their lower ends bent outward into the concrete platform, giving great rigidity. Their upper ends, extending 2" above the top of the pier, are threaded to receive nuts which hold in place a wooden block carrying the mounting head.

This block is of oak, 4" thick, mortised to receive the mounting, which is fastened by three wood screws. I avoided drilling holes in the metal by using three large washers that project over the edge of the mounting base to hold it securely. Leveling is by means of two small glass levels, set at right angles to each other, and shims inserted between the top of the pier and the oak block.

When not in use, the telescope can be left in place under a waterproof cover, or removed in a few seconds by loosening the screws.

My total cost was about $65: ready-mixed concrete, $35; pipes and lumber, $11; and 11 hours labor, $19. The expense would be increased if the ground must be leveled beforehand.

No reinforcement was used in the cement platform. Wire mesh would probably be necessary in regions where freezing and thawing of the ground are frequent.

I shall be glad to supply further information to any amateur wishing to construct a pier of this type.

J. A. E. EYSTER
Matlacha Station
Ft. Myers, Fla.

LETTER OF CORRECTION

Sir:

Let me point out a mistake in the reproduction of the formula on page 534 of the August issue for the angle $\mathbf{A}_2$, the secondary mirror tilt in a neo-brachyt telescope. According to my book, *Der Schiefspiegler,* it should be:

$$\sin \mathbf{A}_2 = \frac{(1/\mathbf{R}_1)^2 \sin \mathbf{A}_1}{(\mathbf{r}_2/\mathbf{r}_1)^3\,(1/\mathbf{r}_2 + 1/\mathbf{P})\,(1/\mathbf{R}_2)}.$$

The application of a *single* plano-convex cylindrical lens as a corrector of the residual astigmatism *near* the secondary focus is not an ideal construction. While the astigmatic difference of focus is eliminated on the optical axis by bringing the two images into coincidence, the difference in focal lengths is not adjusted. The resulting difference of magnification in images at right angles to each other gives an elliptical appearance to an object like the moon.

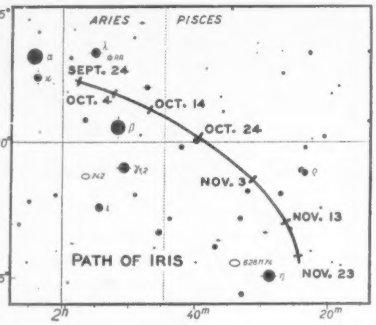
If a single plano-convex cylinder is used as a corrector, this lens must be placed near the secondary and must possess a special computed meridional focal length in order to produce a thoroughly corrected secondary focus.

ANTON KUTTER
Biberach a.d. Riss
West Germany

MINOR PLANET PREDICTIONS

Asteroid 7, Iris, will be quite bright at opposition this year. The diagram shows its path from September 24th to November 23rd. As that period ends, this minor planet will be near the perihelion point of its orbit. At opposition on the 21st of October it reaches magnitude 6.8, while on the first date plotted it is at 7.2, on the last date 7.1.

On the 4th of October, the asteroid will be almost due north of Beta Arietis and should be readily picked up in binoculars or telescopes.



The path of Iris among the stars of Aries-Pisces, plotted on the Skalnate Pleso atlas, which shows stars down to magnitude 7.75 — significantly fainter than Iris.

Iris, 7, 6.8. September 24, 1:57.6 +22-11. October 4, 1:53.9 +21-58; 14, 1:47.4 +21-15; 24, 1:39.6 +20-06. November 3, 1:32.3 +18-39; 13, 1:26.9 +17-09; 23, 1:24.7 +15-49. Date of opposition, October 21.

Vibilia, 144, 9.2. October 4, 2:41.8 +8-36; 14, 2:35.7 +8-15; 24, 2:27.4 +7-54. November 3, 2:18.3 +7-37; 13, 2:09.8 +7-31; 23, 2:03.4 +7-39. Date of opposition, October 31.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

CELESTIAL CALENDAR

Universal time (UT) is used unless otherwise noted.

A Favorable Month for Occultations

FOR OCTOBER we list nine occultations of stars brighter than magnitude 5.0, including Lambda Geminorum, 3.6; Beta Capricorni, 3.2; and Delta Tauri, 3.9.

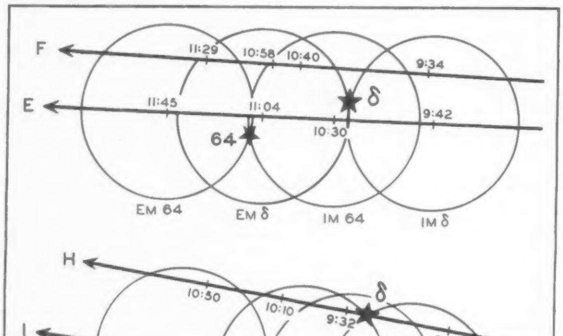
Observers in the middle and western parts of the United States will see the moon pass in front of Lambda Geminorum on the early morning of Monday, October 6th. At station **E**, in western Illinois, immersion at the bright limb of the waning moon is scheduled for 5:28.5 a.m. Central standard time, and the time is earlier westward. Emersion will be visible only in the Far West.

On the evening of Sunday, October 19th, a seven-day-old moon will occult Beta Capricorni for Pacific Coast observers, the event lasting more than an hour at station **H** (central California) and **I** (Vancouver, British Columbia).

About one minute of arc west of Beta Capricorni is the star 16B Capricorni, magnitude 6.2. It will disappear at the dark limb of the moon about eight minutes before Beta.

When the moon is about three days past full, on the morning of October 30th, two bright stars in the Hyades, Delta and 64 Tauri, will be occulted in quick succession. The diagram gives the apparent paths of the moon's center past these stars, as seen by watchers at four stations in the United States and Canada. It is evident that from **E** the moon's center will appear to pass between Delta and 64 Tauri and that for a period after about 4:30 a.m. CST both stars will be behind the moon.

The emersion of Delta is scheduled for 4:58 a.m. CST at station **F**. Observers in far southern Texas may witness the unusual event of one bright star emerging from occultation while another is being occulted. As the eastern side of the moon will be bright, however, it will be much more difficult to see 64 Tauri than Delta at this time. In the eastern part of the country, the coming of daylight may also interfere with observations of 64 Tauri, but west of the Mississippi River its emersion from the dark limb of the moon will occur well before sunrise.



For stations E and F in the central part of the United States, and for H and I on the West Coast, the apparent track of the moon's center is plotted here, in relation to the stars Delta and 64 Tauri. Each track is marked in Universal time for the moments of immersion and emersion, and the circles are drawn in the upper chart for these positions of the moon at station E and in the lower chart for station I. The times for the immersion of 64 Tauri, not listed by the "American Ephemeris," are approximations.

October 2-3 **64 Tauri** 4.8, 4:21.7 +17-20.9, 20. Em: **A** 3:08.0 −1.0 −0.3 317; **B** 3:03.4 ... ... 335; **C** 3:04.9 −0.6 0.0 310; **D** 2:58.0 ... ... 340.

October 3-4 **119 Tauri** 4.7, 5:29.7 +18-33.9, 21. Em: **H** 12:16.1 ... ... 321.

October 5-6 **Lambda Geminorum** 3.6, 7:15.7 +16-37.1, 23. Im: **E** 11:28.5 −2.1 0.0 99; **F** 11:20.3 −2.3 −1.9 134; **H** 10:37.6 −1.2 +0.5 107; **I** 10:54.5 −0.7 +2.4 62. Em: **H** 11:54.1 −1.7 +1.3 262; **I** 11:54.9 −1.3 −0.4 309.

October 7-8 **Alpha Cancri** 4.3, 8:56.2 +12-01.3, 25. Em: **C** 7:37.1 ... ... 349.

October 15-16 **Chi Ophiuchi** 4.8, 16:24.6 −18-21.8, 3. Im: **H** 2:59.3 −0.3 +0.3 47.

October 18-19 **Rho Sagittarii** 4.0, 19:19.2 −17-55.7, 6. Im: **I** 1:33.9 −2.0 −0.9 129.

October 19-20 **Beta Capricorni** 3.2, 20:18.7 −14-54.9, 7. Im: **H** 5:17.3 −1.6 −1.1 91; **I** 5:06.1 −0.9 −0.2 53. Em: **H** 6:24.4 −0.4 +0.3 227; **I** 6:13.4 −0.9 −1.4 269.

October 29-30 **Delta Tauri** 3.9, 4:20.5 +17-26.7, 18. Im: **A** 10:11.2 −1.3 −0.1 59; **B** 10:10.0 −1.3 +0.3 49; **C** 10:06.1 −1.4 −0.5 74; **D** 10:01.3 −1.5 +0.1 59; **E** 9:41.7 −2.0 −0.2 76; **F** 9:33.5 −2.5 −1.6 109; **H** 8:35.0 −2.2 +1.0 80; **I** 8:57.4 −1.1 +3.4 31. Em: **D** 11:07.3 −0.6 −2.3 298; **E** 11:03.8 −1.2 −1.5 278; **F** 10:58.4 −2.0 +0.4 243; **H** 10:09.7 −2.4 +0.4 259; **I** 9:52.4 −2.1 −2.2 310.

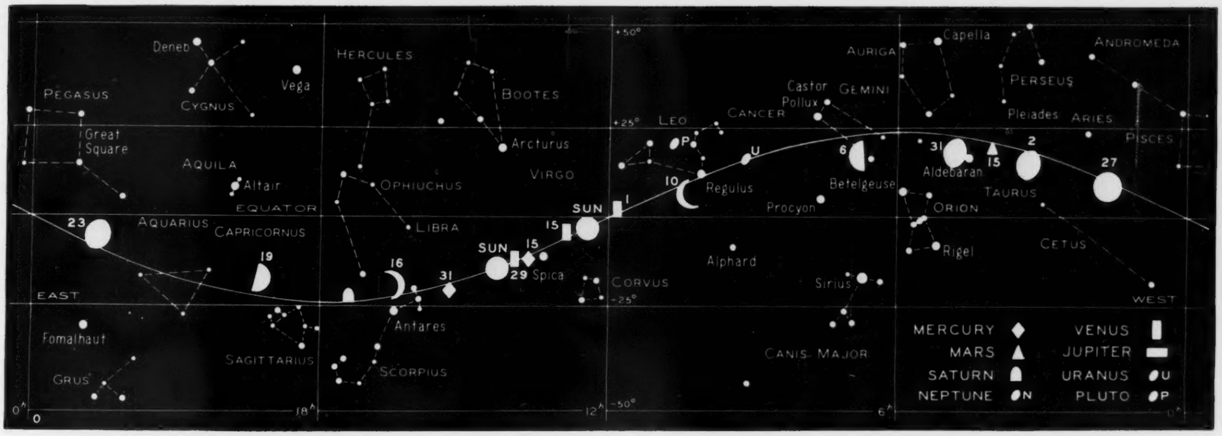
October 29-30 **64 Tauri** 4.8, 4:21.7 +17-20.9, 18. Em: **E** 11:45.0 −1.1 −0.7 254; **F** 11:29.1 ... ... 211; **H** 10:50.3 −2.3 +2.0 226; **I** 10:50.0 −1.7 −0.6 274.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard-station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo−LoS**), and multiply **b** by the difference in latitude (**L−LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
		I	+123°.1,	+49°.5	



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

The sun will be totally eclipsed on October 12th along a path starting in the Pacific Ocean east of New Guinea, crossing the South Pacific, and ending in Argentina. Maximum duration of the total phase is 5 minutes 11 seconds. (See page 615.)

The moon passes through the penumbra of the earth's shadow on October 27th, beginning at 13:16 UT, according to the *Handbook* of the British Astronomical Association. Maximum phase (with 81 per cent of the moon's diameter in the penumbral shadow) occurs at 15:27, and the event ends at 17:39. This appulse will be invisible in most of the United States, but West Coast observers may see a slight darkening of the full moon's northern limb just before moonset.

Mercury passes from the morning to the evening sky, superior conjunction occurring on October 5th. This planet will be too near the sun for observation during the entire month.

Venus will be difficult to observe this month as it is near the sun. In Virgo, the planet is of magnitude −3.4, and on the 15th rises half an hour before the sun.

Mars continues to increase in brightness as it approaches opposition in mid-November. On October 1st it is of magnitude −1.2 and 16″ in diameter; on the 31st it is −1.8 and 19″. Mars will be stationary in right ascension on the 9th, beginning retrograde (westward) motion among the stars. By the 15th the planet will rise about two hours after sunset, a conspicuous object in Taurus the rest of the night.

Jupiter is poorly placed for observation this month, setting low in the southwest soon after the sun.

Saturn at midmonth will be a +0.8-magnitude object in Ophiuchus, northeast of Antares. It can be seen in the southwestern evening sky, setting about three hours after the sun goes down. Toward the end of October, Saturn's rings have their greatest inclination, the north face of the system being tipped almost 27° to our line of sight. Throughout October Saturn's polar diameter is very nearly 14″.

Uranus is in Cancer, at apparent right ascension 9^h $13^m.5$, declination +16° 45′.1 on the 15th. Before dawn, this 6th-magnitude planet is well up in the east, an easy object in binoculars.

Neptune will be in conjunction with the sun on the 28th and hence too near it for observation this month.

Artificial satellite observations in October can be made with the aid of the star chart from a September issue for evening twilight, from a February or March issue for morning.

W. H. G.

VARIABLE STAR MAXIMA

October 5, R Sculptoris, 0122**33**, 5.8; 6, R Bootis, 143227, 7.3; 6, RV Centauri, 1331**55**, 7.6; 8, R Cygni, 193449, 7.3; 8, V Cassiopeiae, 230759, 7.9; 13, T Cephei, 210868, 5.8; 17, T Aquarii, 204**405**, 7.9; 18, R Leporis, 045**514**, 6.7; 24, U Ceti, 0228**13**, 7.5.

November 1, S Ursae Majoris, 123961, 7.9; 7, R Virginis, 123307, 6.9; 9, R Phoenicis, 2351**50**, 7.8.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MINIMA OF ALGOL

October 1, 0:42; 3, 21:31; 6, 18:19; 9, 15:08; 12, 11:57; 15, 8:46; 18, 5:34; 21, 2:23; 23, 23:12; 26, 20:01; 29, 16:50.

November 1, 13:39; 4, 10:27; 7, 7:16.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

MOON PHASES AND DISTANCE

Last quarter	October 6, 1:20
New moon	October 12, 20:52
First quarter	October 19, 14:07
Full moon	October 27, 15:4
Last quarter	November 4, 14:19

October	Distance	Diameter
Perigee 13, 2^h	221,900 mi.	33′ 28″
Apogee 27, 0^h	252,500 mi.	29′ 25″
November		
Perigee 10, 14^h	222,300 mi.	33′ 24″

OCTOBER METEORS

The moon, at first quarter on the 19th, will not seriously interfere with observations of the Orionid meteors. The shower lasts for 10 days, from October 15th to 25th, and an hourly total of about 20 swiftly moving meteors may be seen at maximum on the 20th. The radiant is roughly 10 degrees northeast of Betelgeuse.

The Taurid shower begins in late October and reaches maximum on November 5th, when about 12 meteors may be counted each hour.

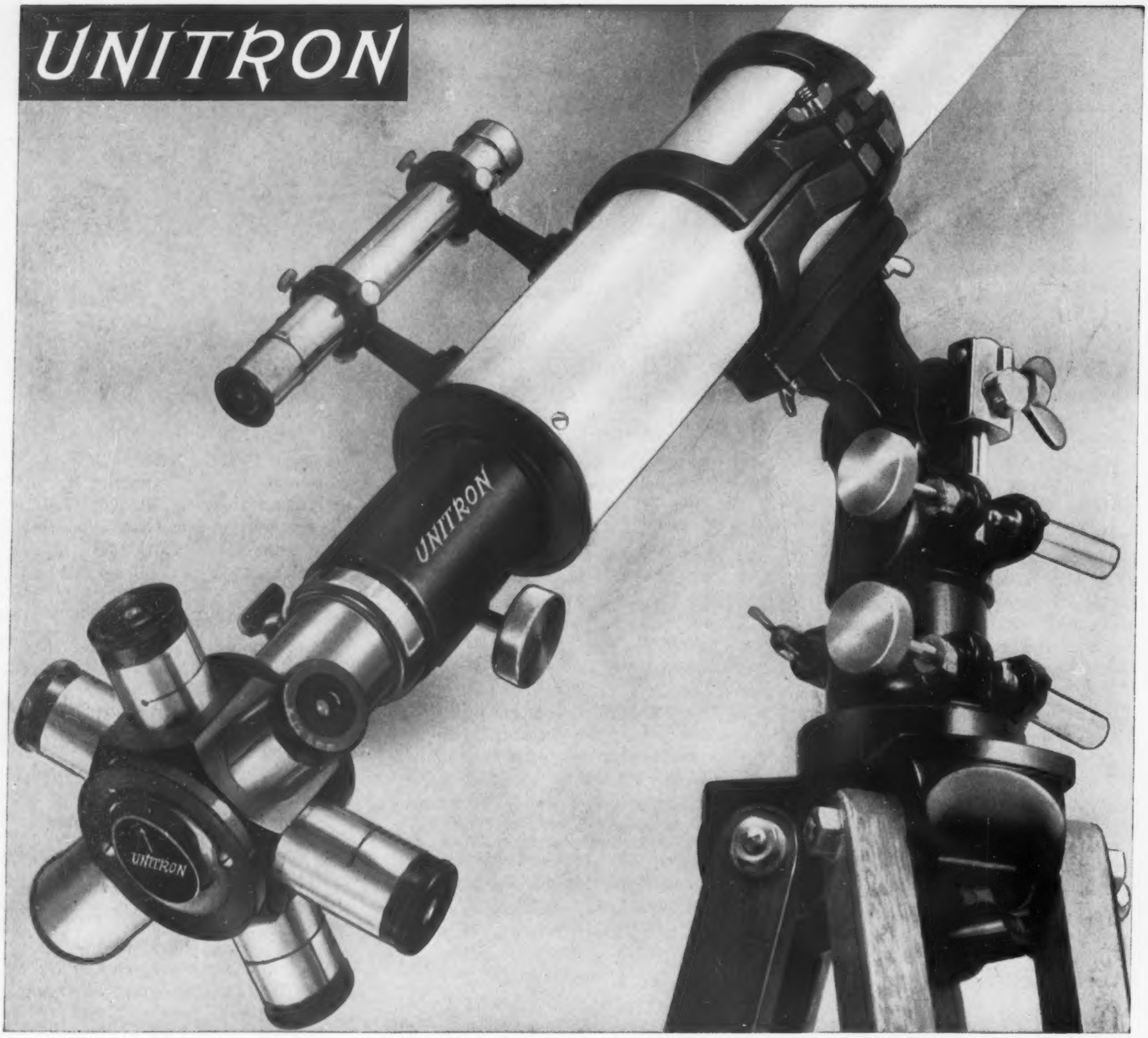
According to the 1958 *Handbook* of the British Astronomical Association, perturbations in 1956-57 may result in the earth meeting the Giacobinid meteors on the night of October 9-10 this year. It is emphasized that this is only a possibility. If the longitude of the node has not altered to any great extent, maximum should occur about midnight in the eastern United States.

The Giacobinids were last seen in 1946, when 60 to 100 per minute were reported, despite an almost full moon. IGY world days for the possible observing of this shower have been scheduled for October 9-10, 10-11, 11-12, and 12-13.

W. H. G.

UNIVERSAL TIME (UT)

TIMES used in Celestial Calendar are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. To obtain daylight saving time subtract 4, 5, 6, or 7 hours, respectively. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.



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UNITRON ADDS NEW ACCESSORIES

Many new accessories have been added to the UNITRON line, including a Herschel solar diagonal, an illuminated crosshair diagonal, filar micrometer eyepiece, etc. All are built to UNITRON's high standards of optical and mechanical excellence. Write for Bulletin NA.

- LENSES are FULLY CORRECTED for spherical and chromatic aberration and are COATED for maximum brilliance and clarity of image. Optics especially designed for astronomical observation. AIR-SPACED OBJECTIVES.
- EYEPIECES of the HIGHEST QUALITY: Orthoscopic, Achromatized Symmetrical, Kellner, Huygens. Three to ten eyepieces included with each instrument.
- EQUATORIAL MODELS have slow-motion controls for **both** declination and right ascension as well as rapid-motion controls. Sturdy TRIPOD (or PIER).
- ALTAZIMUTH MODELS have slow-motion controls for **both** altitude and azimuth as well as clamps for both co-ordinates. Sturdy TRIPOD.
- Choice of UNIHEX Rotary Eyepiece Selector or STAR DIAGONAL and ERECTING PRISM for TERRESTRIAL OBSERVATION.

Higher- and lower-power eyepieces available for all models. Prices include basic accessories, tripod and mounting, fitted wooden cabinets, and operating instructions. Additional accessories available to add further to your observing pleasure.

HOW TO ORDER A UNITRON

Send check or money order in full or use our Easy Payment Plan, as described below. Shipments made express collect. Send 20% deposit for C.O.D. shipment. UNITRON instruments are fully guaranteed for quality, workmanship, and performance, and must meet with your approval or your money back.

Use Our EASY PAYMENT PLAN

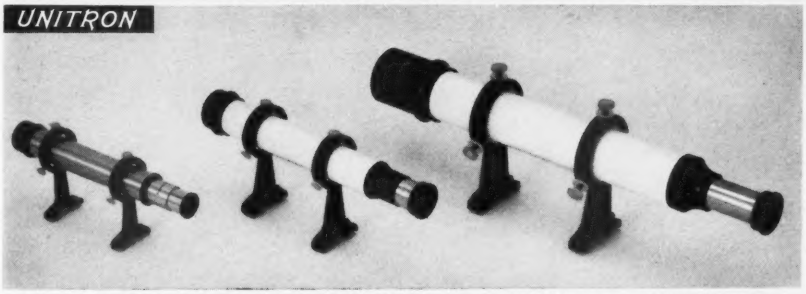
UNITRON's popular Easy Payment Plan is a convenient and economical way to buy your UNITRON Refractor when you do not want to disturb your savings or when you haven't the total cost of the telescope immediately available. The down payment required is 10%. The balance due is payable over a 12-month period, and there is a 6% carrying charge on the unpaid balance. Your first payment is not due until 30 days after you receive the instrument, and if you should want to pay the entire balance due at that time, the carrying charge is canceled. (6" models available on special plan.)

NEW SATELLITE TELESCOPE

Here is THE Satellite Telescope for the critical observer who will settle for nothing short of the very best. Invaluable for MOONWATCH program, as wide-angle finder, for comet seeking, meteor counting, and rich-field observing. Outstanding features include 50-mm. objective; 6x, 12° field, high-eyepoint, crosshair, diagonal eyepiece with rack-and-pinion focusing; sealed-in aluminized mirror; sturdy altazimuth mounting with graduated circles, etc.

Write for Bulletin ST. Price $75

New UNITRON View Finders



UNITRON's popular view finders with newly designed optics and mechanical features are better than ever; from left to right: 23.5 mm., 30 mm., 42 mm.

1. VIEW FINDER (As used on UNITRON 2.4" Models): 23.5-mm. (.93") achromatic objective, 6x eyepiece with crosshairs. Chromed brass tube. Mounting brackets with centering screws. **Only $8.50 postpaid**

2. VIEW FINDER (As used on UNITRON 3" Refractors): 30-mm. (1.2") coated achromatic objective and 8x eyepiece with crosshairs. Other details as in View Finder 3. **Only $10.75 postpaid**

3. VIEW FINDER (As used on UNITRON 4" Refractors): 42-mm. (1.6") coated achromatic air-spaced objective. 10x eyepiece with crosshairs. Duralumin tube finished in white enamel. Dewcap. Furnished with mounting brackets, centering screws for collimation, and mounting screws. This finder measures approximately 16" overall. It is light in weight, compact and small enough for use as a hand telescope furnishing spectacular wide-field views of the sky. **Only $18.00 postpaid**

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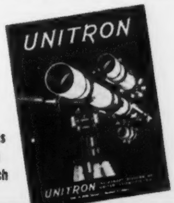
Get UNITRON's FREE Observer's Guide and Catalog on ASTRONOMICAL TELESCOPES

This valuable 38-page book is yours for the asking!

With artificial satellites already launched and space travel almost a reality, astronomy has become today's fastest growing hobby. Exploring the skies with a telescope is a relaxing diversion for father and son alike. UNITRON's handbook contains full-page illustrated articles on astronomy, observing, telescopes and accessories. It is of interest to both beginners and advanced amateurs.

Contents include—

- Observing the sun, moon, planets and wonders of the sky
- Constellation map
- Hints for observers
- Glossary of telescope terms
- How to choose a telescope
- Amateur clubs and research programs



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Please rush to me, free of charge, UNITRON's new Observer's Guide and Telescope Catalog 20-J.
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Street ______
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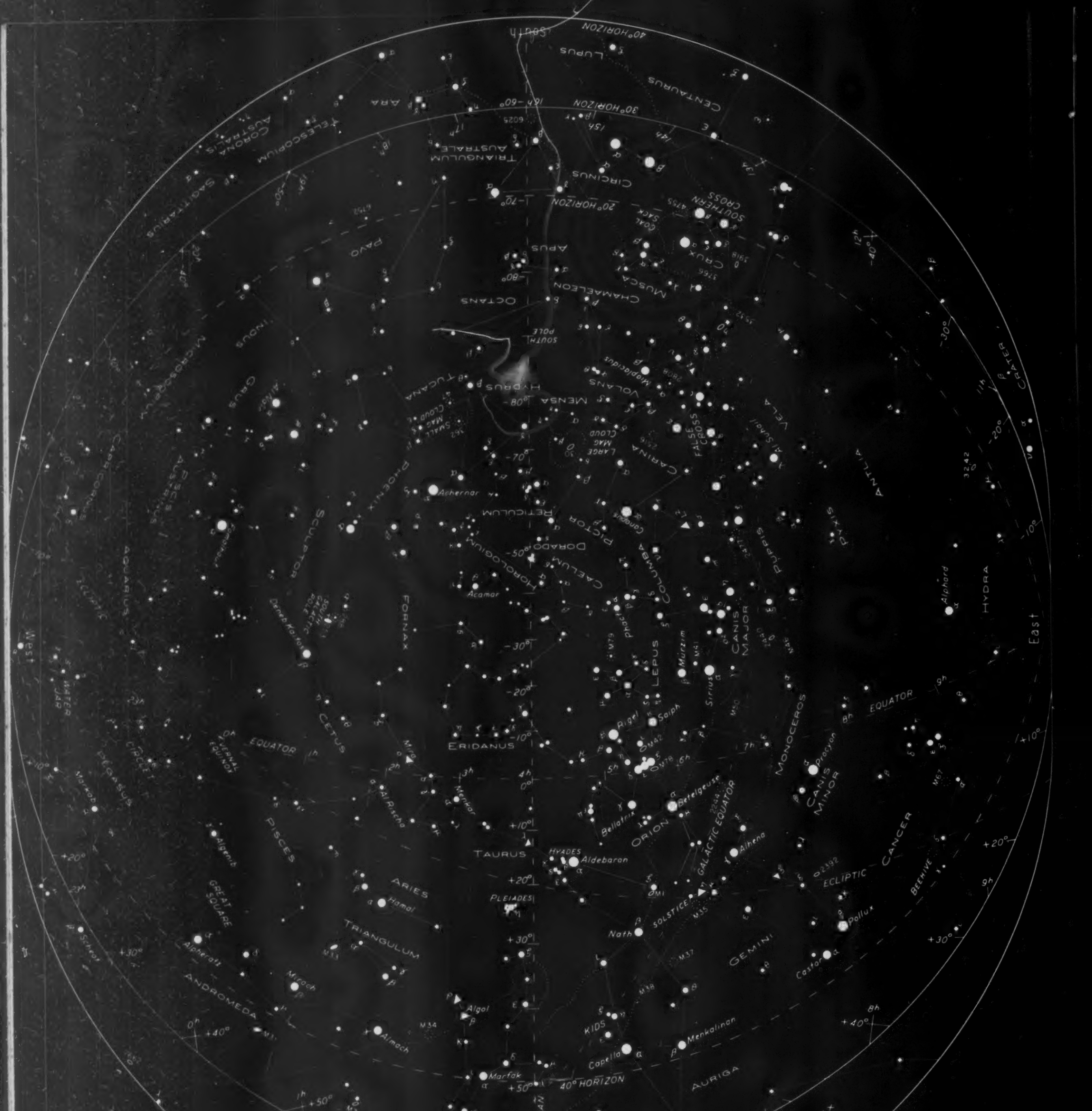
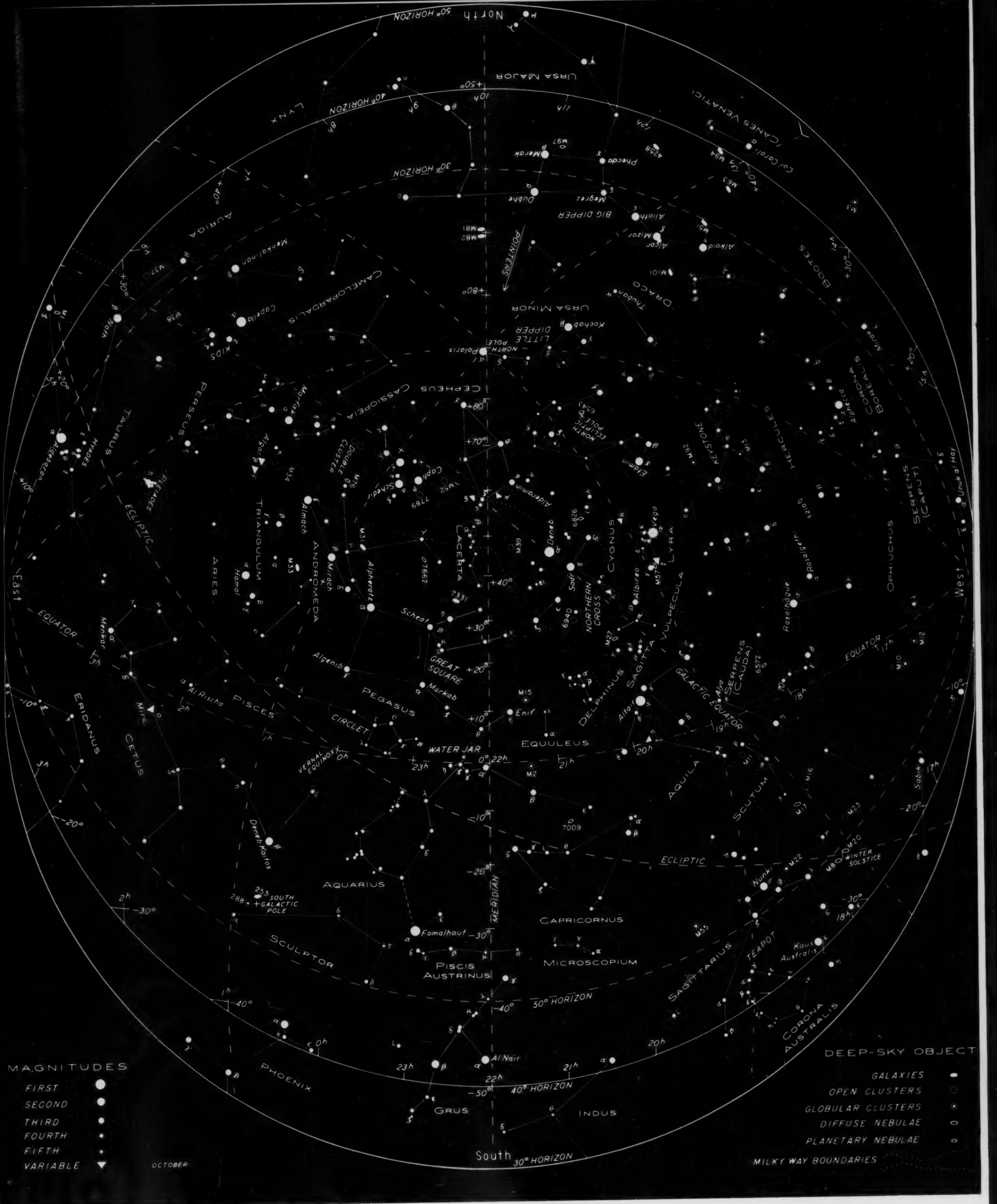


SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of December; also, at 9 p.m. and 8 p.m. on January 7th and 23rd. For other dates, add or subtract ½ hour per week. When facing south, hold "South" at the bottom; turn the chart to observe in other directions.

Taurus, now on the meridian, presents a striking sight in the northern sky: red Aldebaran, the V-shaped Hyades, and the compact Pleiades cluster. How many of the Seven Sisters can you count?



STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of October, respectively; also, at 7 p.m. and 6 p.m. on November 7th and 23rd. For other dates, add or subtract ½ hour per week.

The northern Milky Way now stretches across the sky directly overhead. Little Lacerta, the Lizard, is just east of the meridian at chart time. Cepheus, on the northern side of the Milky Way, is now at its highest; look there for the famous variable Delta.

Illustrated above: 6" De Luxe Dynascope*
*Reg. U.S. Pat. Off.

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A Masterpiece of Design and Craftsmanship

6" STANDARD MODEL

Criterion's Famous Dynascopes*

6" – 8" – 10" – 12" – 16" starting as low as $265

Custom built to meet a professional's exacting specifications
Priced within easy reach of the serious amateur

Only Criterion could produce such magnificent instruments at such reasonable cost. Combining the latest advances in optical engineering with the old-world skill and patience of master craftsmen, these superb new Dynascopes, custom made, offer top-quality performance. Every feature necessary for superior viewing is precision finished to professional standards. Optical surfaces accurate to 1/10 wave.

The five matched eyepieces are the finest orthoscopic and achromatic. Mechanical features are carefully custom built to assure trouble-free operation. Construction throughout is of lifetime materials. There are both maximum rigidity and easy portability.

Above all, Criterion's strict quality control allows no room for chance. Each Dynascope is doubly tested and inspected; these rigid tests must be flawlessly met before shipment. Your satisfaction UNCONDITIONALLY guaranteed. Yet the price is amazingly low.

6" Standard Model (80 lbs. shipping weight f.o.b. Hartford) **$265**
Also Illustrated: Electric Clock Drive, $80; Setting Circles, $60; Permanent Pedestal, $70.
Write today for full specifications and details of these superior reflecting telescopes.
Easy-payment terms available on request.

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Compare These Superior Features Which Include

- f/9 Parabolic Mirror, accurate to 1/10 wave
- Fully Rotating Tube, for comfortable viewing
- Massive Equatorial Mount, adjustable for your latitude
- 5 Matched 1¼" Eyepieces — 3 Achromatic Ramsdens (45X, 76X, 152X) — 2 Orthoscopics (228X, 343X)
- 8 x 50 Achromatic Finder Scope with cross-hairs
- Secondary Support that minimizes diffraction
- Declination Axle, 1½" diameter, with slow motion
- Polar Axle with Needle Bearings on 1½" shaft
- Rack-and-pinion Focusing
- Double-draw Focusing Tube for any eyepiece
- Precision-fashioned 54" Bakelite Tube
- Lightweight Portable Tripod (hidden inside pier of de luxe model illustrated) for field trips
- Exclusive Two-way Pier-tripod — a massive 46-pound pier for permanent installation


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This 4" UNITRON is yours for only $128 down
You can tell at a glance that here is a telescope designed to achieve professional results. Indeed, this 4" UNITRON has been chosen for important research by university observatories, the U. S. and foreign governments, and leading industrial laboratories. Ownership of such a superb instrument might be thought to be beyond the means of many amateur astronomers, yet a 10% down payment of only $128 puts you at the controls of this magnificent UNITRON.
The full purchase price of $1280 includes everything the serious observer wants and needs to make the most of his observing — clock drive, fixed pier, Astro-Camera, 2.4" photographic guide telescope, Super-UNIHEX, large 42-mm. 10x view finder, eyepieces, and a complete selection of accessories in addition to these pictured above.
With this 4" UNITRON, you have at your disposal a complete range of magnifications: 25x, 38x, 60x, 83x, 120x, 167x, 214x, 250x, 300x, 375x. And, with the Super-UNIHEX Rotary Eyepiece Selector, you can switch from a spectacular wide-field view of the sky to high-power observation of planetary details at a flick of a finger.
There are other UNITRON 4" models for as little as $465 complete ($46 down) and other UNITRON Refractors for as low as $75 ($7.50 down). All may be purchased using our Easy Payment Plan. Whichever model you choose, you are assured of obtaining the finest instrument in its class. After all, it is a UNITRON.
See pages 658 and 659.
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